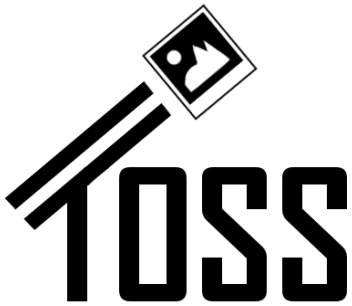
That One Special Shot



Final report

TOSS TEAM

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Table of Contents

1 Executive summary 3
2 Project background 3
2.1 Needs statement 4
2.2 Goal and objectives 4
2.3 Design constraints and feasibility 4
2.4 Literature and technical survey 5
2.5 Evaluation of alternative solutions 6
3 Final design 7
3.1 System description 7
3.2 Complete module-wise specifications 9
3.3 Approach for design validation 15
4 Implementation notes 16
5 Experimental results 38
6 User's Manuals 43
7 Course debriefing 62
8 Budgets 64

1 Executive summary

It has never been easier to take photos at public events. Yet ironically it remains difficult to gather all the photos taken at them. To this end, our group has created “That One Special Shot” (TOSS), an application which will facilitate the collection and distribution of photos. Using TOSS, users will be able to take a photo at a specific event and upload it in real time to an online, crowd-sourced photo database. After the event, TOSS will allow them to download the photos from the database for free.

In chronological order, TOSS will function in the following manner:

1. An event's host will create an account on our website. For each event, hosts will need to specify a six-character Event Code, which in turn can be linked to a QR code. Both the QR code and the Event Code will be linked to a private Event ID (a unique, assigned, 32-digit number identifying the event in our system).
2. The host will then share the Event Code or QR code with the event’s attendees. Anyone with access to the Event Code or QR code will be able to upload photos to our system for a period of time specified by the event’s host.
3. While at the event, attendees will take photos. TOSS will automatically upload the photos to the server specified by the Event ID.
4. Only users with the Event ID and password can access photos on the database.

Downloading photos presents its own problems: in many scenarios a user will not want to access all of the photos taken at an event (imagine a football game where tens of thousands of photos might be taken). TOSS provides two solutions to this problem. First, the user will be able to access the photos in a list format on the website. He can therefore download only those specific photos he appreciates. Second, TOSS allows for photo tags and comments which the photos can be filtered by. This way, a user can search for only those photos which include certain tags or comments in it.

TOSS implements a number of security features to maintain our users’ privacy. First, only those creating events will need to create accounts. As long as an event's attendees have access to the Event ID and password, they can download photos taken at the event. This way, they can maintain their privacy, even within our system.

Second, our website will also add photo tagging and commentary so photos can be searched through conveniently. However, these tags and comments are kept internally, and not shared with anyone. When the user downloads the photos, all tags and comments are stripped.

2 Project background

At any large gathering – whether it be a wedding, convention, or sporting event – attendees will want to both take photos and see photos taken by others. With the proliferation of smartphones, taking photos has never been easier. Retrieving others’ photos, however, remains cumbersome. It is cumbersome because no one wants to engage in the time consuming task of contacting photographers individually (this assumes, of course, we have their contact information) and getting their photos in that manner. A way to easily create and access a crowd-sourced photo database would be beneficial. The TOSS application, whose design is the basis for this document, has created such a database. It gives users a variety of storage and access options as well as numerous security features.

2.1 Needs statement

Current software which attempts to create these databases are inadequate, for none come close to providing TOSS's range of functionality. TOSS is distinct from current applications in the following three ways.

First, photos can be stored in one of two locations, Dropbox or an FTP server. Current applications only support one type of storage, severely limiting the consumer's choices and thus making it less likely that the application will suit their needs.

Second, TOSS implements numerous measures to ensure and maintain its users' privacy and security. Our research into other applications has shown that this is not a passing concern for other software. However, as internet users become more concerned with their privacy online, any form of social media (including crowd-sourced photo databases) must take this concern seriously.

Third, and perhaps most important, TOSS is free. Any application currently on the market which comes close to offering our range of functionality is either inherently for profit or must charge the users a fee to recoup the money needed to store all of its users' photos.

2.2 Goal and objectives

With TOSS, we have created the crowd-sourced photo database described above. Using our app, anyone with the proper permissions will be able to upload a photo they have taken in real time to either a Dropbox or FTP account, the databases our application supports.

In addition TOSS also provides various methods of privacy and security for free.

In order to keep the program free, our method of storage is free as well. To do this, TOSS leverages the Dropbox API (which allows users to upload photos to designated Dropbox account) as well as the Apache Commons library (which allows users to upload photos to a designated FTP account).

2.3 Design constraints and feasibility

Many of the constraints on TOSS derive from the fact that it is our aim to keep TOSS free. For an application to be free, our storage must be free, and to keep the storage free we had to leverage different APIs. It is here where we encountered the most constraints. Constraints stemming from these APIs fit into two categories: poor documentation or lack of a dedicated API.

First, because the APIs for these social media siteS change so quickly, proper documentation often goes undone. Many tutorials are therefore out of date and useless. A programmer could spend several hours working through a tutorial only to find that the tutorial's recommendations are no longer valid.

Second, though all social media websites have some form of an API, not all have a dedicated APIs in the language we were using, Java. As an example, Facebook only provides APIs for iOS, Android, PHP and Javascript. There are third party API's written in Java, but these are not as well kept as the APIs Facebook provides in house.

Other constraints we encountered were constraints inherent to nature of web applications and Android applications. A web application allows for maximum storage capacity (necessary for when users download their photos) but could be cumbersome to use on a phone. One can imagine the tediousness of taking a photo, saving it, opening one's browser, uploading the photo, closing the browser, before starting the entire process again.

An Android app could circumvent this problem -- simply take a photo and directly upload it Dropbox or an FTP server using their respective APIs. However, because of the Android's limited storage capacity, downloading the photos after they have been uploaded becomes infeasible.

2.4 Literature and technical survey

There are several existing products that solve the same issue of event photo collection that TOSS aims to address. These existing products have a wide range of capabilities. The more capabilities the product has, the costlier it is. One aspect not addressed in any of the existing products we reviewed is storage variety. All the applications stored photos using their own storage, either internally or externally using cloud services. This type of storing inflates the cost of the product to the user, and also raises privacy and security concerns. TOSS allows the user a variety of storage options. TOSS does not keep any photos, instead it only directs them to the storage specified by the user. This not only provides flexibility and privacy to the user but it also reduces the operating cost of TOSS.

- **Wedding Snap**
  - Wedding Snap is a photo service geared specifically towards weddings. The website allows event hosts to create albums, and event guests to upload photos and videos through their Android and iPhone applications, or email them. Photos can then be downloaded on the computer through their website. They also provide some bonus services like live slide shows, and twitter hashtag uploads.
- **Sharypic**
  - Sharypic is another application that allows for collaborative photo galleries. It allows users to upload photos from any device including cameras, mobile devices, or computers. Photos can also be uploaded using twitter and instagram hashtags. Photos can then be downloaded on the computer through their website. They also provide some bonus services like live slideshows, importing photos from existing photo services.
- **Bonfyre**
  - Bonfyre is a service for group collaboration. This service provides group messaging, and content sharing across several platforms including Android and iOS. It's capabilities are geared more towards chatting and messaging rather than photo and content sharing.
- **Fotojelly**
  - Fotojelly is a photo sharing service that is only available on Windows phones. This application is mostly used for social network integration. The application pulls photos from Facebook events and groups.
- **Napa**
  - Napa is a photo sharing service available only on iOS. It focuses on security. Photos can only be shared with 'contacts' that have been imported into the application.

	Wedding Snap	**Sharypic**	**Bonfyre**	**Fotojelly**	**Napa**	**TOSS**
Storage Variety	None	None	None	None	None	DropBox FTP Private Server
Upload	Yes	Yes	Yes	Yes	Yes	Yes
Upload Varieties	Android iOS Computer Twitter/Instagram Camera Email	Android iOS Computer Twitter/Instagram/Facebook/Flickr/Picasa Camera	Android iOS	Windows Phone Facebook	iOS	Android Computer Email

		Email				
Upload Features	Photo filters	None	None	Editing	None	Photo filters Editing Comments Tagging
Download	Yes	Yes	No	No	No	Yes
Privacy Features	Code	Code Password	Code Password	Code Password	Share Only via Phone or Email	Code Password
Cost	$99 - $399	$199 - $499 per month	$0	$0	$0.99	$0

Table of Product Features

2.5 Evaluation of alternative solutions

One alternative solution to ours is to supply everyone at an event with disposable cameras. This is actually how group photo sharing is done at many weddings. Everyone who is attending the wedding will get a disposable camera which they will turn in at the end. This allows the bride and groom to have pictures from everyone that attended the wedding. The downside is that the guests that are attending the wedding will not have a copy of the pictures that are taken with the cameras, there is a big cost is buying that many disposable cameras and the number of photos is limited to the amount a single camera can take. For events in which the guest list is unknown, this solution becomes near impossible. The benefits however is that it is simple to just buy cameras and distribute them so setup is easy.

A second solution was to create a program that could be installed on a computer that is owned by the host. This program would function similar to our website in that it would handle to receiving of photos and direct them to the correct storage location. The downside to this approach is that the setup to get the program functioning correctly would require port forwarding on the hosts network which we did not believe that average user would be able to do. Another problem is that instead of using a code to connect to an event like we do, the host would have to provide a server address and port number which would significantly increase the complexity of connecting devices to the event. Especially when the event is an open even with no guest list since directions must be posted in a public space instead of explained in a detailed letter or other such medium. The benefit of this solution would be that the photos never spend any time on a server that is not owned by the host which would allow the ultimate level of privacy and security for the users.

A final solution would be to ask everyone who attended the event to send a copy of their photos to the host, most often by email. This solution is the cheapest because there is no hardware or software to be purchased and there is no setup except for asking everyone to send their pictures. The downside however is that it depends on everyone to remember to send their photos after the event as well as be willing to take the time to do it. Guests will be much more willing to help the host with photos when it is not a hassle to themselves. This solution has one of the highest levels of effort required by each guest since they must upload their photos to a computer and send them in a timely manner after the event.

After looking at the three solutions above we came up with our solution as it takes the best of each solution and sacrifices little. The benefit of our solution over the disposable cameras is that we offer our service for free, so the only cost would be the option of buying a storage medium for the photos. This cost is dramatically less than the cost of buying a large number of cameras and the number of photos that every guest can take is not limited. By hosting our service online we can allow guests to connect to an event by simply using a 6 digit code rather than needing various login information and the host does not have to do any setup. This provides huge setup benefits over the installation version of our software. The downside being a slight decrease in privacy since the photos must pass through our servers. The benefit over having the users email their photos after the event is that with our app users can take pictures like they would be doing already and a copy is automatically sent to the host which requires no extra work for the guest. Therefore we have taken the best of all the solutions and really only sacrificed a little privacy in doing so.

3 Final design

3.1 System description

TOSS will be comprised of six main parts: an Android phone, two services, an API abstraction layer, a storage medium, and a database. The Android phone will be the main method of interaction for users. The first web service will be the other method of interaction for the user (frontend), and will control user account creation, login, and photo displays. The second web service will be strictly backend-oriented, handling incoming photos, authenticating device IDs and event IDs, and communicating with the API abstraction layer. The storage medium will be decided by the user at the creation of each event. Storage mediums may be Photobucket, Dropbox, Facebook, or a user's private server. The database will store user accounts, event IDs, and links to photos.

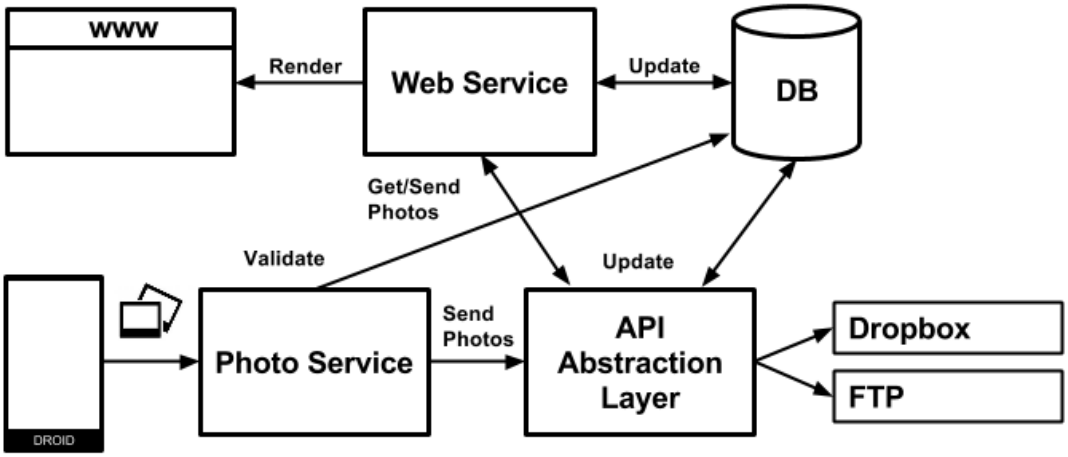


Figure of System Architecture

The Android application will be developed by Gregory. The app will consist of the default camera component, a screen to input an event ID code, and a screen to choose which pictures should be sent to the web service using REST. The Android application will send each photo as a REST call, with image data, tags and comments, device ID, event ID, and time taken present.

The frontend web service will be built using Python and the Django Web Framework. It will handle the creation of user accounts and events, the display of photos, and the downloading of all pictures taken at an event. Kira will handle the technical design of the web service front end. Hao will be in charge of 'branding' the website and creating a uniform look and feel throughout the project. The Python web service will interact with the database to manage account and event creation. It will also interact with the

API abstraction layer to retrieve photos from their respective storages. Event creation will assign a unique identification code to each event, generated through an md5 algorithm. The host of an event will distribute a QR code to his guests. The QR code will translate into an event code, which maps to the unique event ID.

The photo service (backend) will be implemented in Java and Jersey. Jersey is a framework for creating REST applications. Maven will be used to manage dependencies and builds. The web service will be created using Grizzly, a lightweight Java server. Patrick will be working on the photo acceptance and event ID authentication. Josh will be managing the storage of photos in the user's Dropbox, Facebook, or Photobucket account. The decision for splitting the photo-handling service and the user interface service was made by Gregory, to reduce load on the UI while many pictures were being uploaded. This service will communicate with the Android application, database, and Python service. The Android app will send the image, device ID, and event ID, which will be read by the Java service. We will look up the event ID in the database to determine its authenticity. The device ID may be logged to prevent spammers from abusing our system. After the event ID has been verified, the photo will be sent to the API abstraction layer to be placed in its respective storage.

The inclusion of several different storage options for the user allows for more flexibility and privacy than other services may allow. Josh will be in charge of integrating our web services with Facebook's, Dropbox's, and Photobucket's APIs. The list of planned storages is as follows:

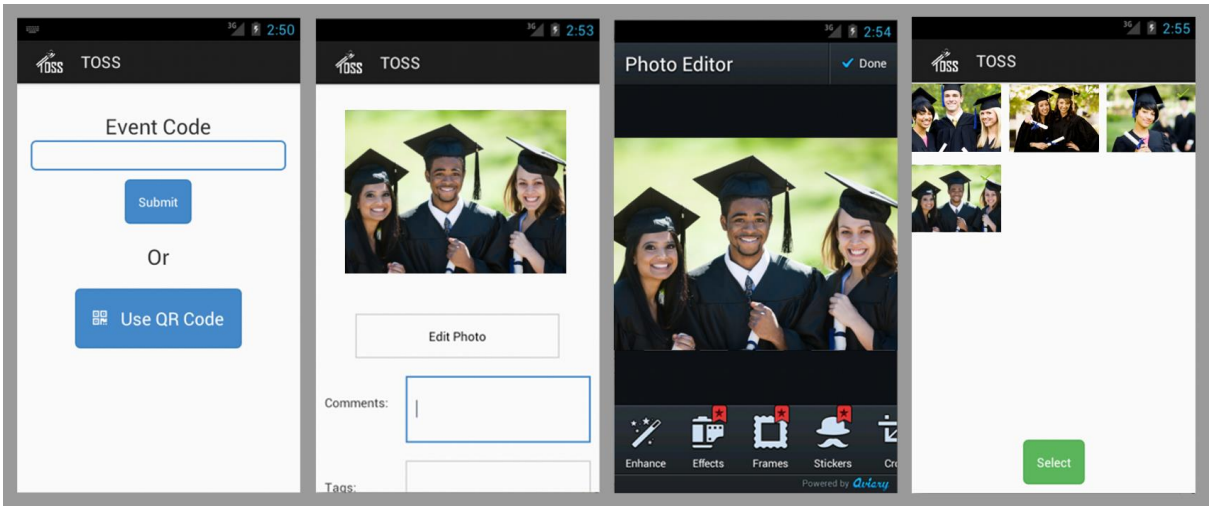
- Facebook
- Photobucket
- Dropbox
- Private Server

The standard services (Facebook, Dropbox…) will be simple to set up. The host for the event will provide his credentials to the specific account to allow our services to upload the guests' photos directly to the account. The private server option is a more technical option for the truly privacy-conscious user. This option will allow the users to bypass all of our services. Instead of giving his guests an event ID, he will distribute a link to his private server, which will collect and display photos sent to it.

The mySQL database will contain information related to user accounts, event IDs and time constraints, and photo links. Zach will set up and maintain the database. The Python web service, Java web service, and API abstraction layer will communicate with the database. The Android apps will never interact directly with the database.

Zach purchased a server NFOservers.com and installed 12.04 LTS Ubuntu distribution. Gunicorn, Nginx, Supervisor, and Virtual Environment are installed on the Linux machine. Most of our development work will be done through this server.

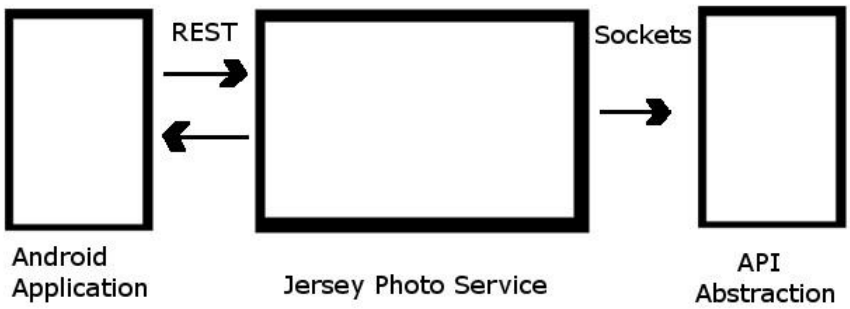
3.2 Complete module-wise specifications



Android Application: start screen, tagging screen, photo effects screen, and reviewing screen.

Android Application

- Requires Android version 4.0 and above because we are using slider switches in our application which is only supported in version 4.0 and above.
- Using Spring API for performing REST calls.
- Using SimpleXML for serializing app data.
- Using ZXing Barcode scanner in order to read QR codes.
- Decided to use a camera intent vs a camera API because the camera intent provides a user interface that is already similar to the default camera app and takes the least amount of effort to implement. The only downside is that we are unable to customize the camera screen.
- Using Aviary API for photo editing.



The relationship between the Android Application, Photo Service, and API Abstraction Layer is shown.

Photo Service

The photo service has been being developed using Java, Jersey (REST), and Grizzly (server). Maven is being used as a dependency handler and build environment. The decision to use Java (as opposed to Python, for example), was based on Java's speed and Patrick's familiarity with the language. Java, being a compiled language, is considerably faster than Python, which is interpreted. Jersey was chosen as a

RESTful service because it seemed to be the most widely-used, and as such, had the greatest amount of documentation available to us. Grizzly was used as the server due to its simple and lightweight nature. Since it is developed by Oracle, and is contained within the GlassFish project, documentation was also abundant. An additional bonus for each of these technologies is that they are all contained within the Central Maven Repository, enabling rapid deployment with minimal hassle. Using a Jersey/Grizzly Maven archetype, we were able to get a simple REST service up fairly quickly. Maven also resolves most of Java's class path headaches when compiling and running. In short, each component's compatibility with Maven created a very pleasant development environment.

The photo service, as of this writing, has two main actions. The first is event code validation, in which a user's Android app will send a REST GET call of the form http://toss.myphotos.cc:18081/validationService/<code>. Plans for the next iteration of design include implementing a caching system to avoid interacting with the database too frequently. The second function is to receive photo and event information from the Android application via Multiparts and pass the relevant data to Josh, who will be managing the API abstraction layer required to transmit the photos to Dropbox and Facebook.

The communication between the Android application and the Jersey photo service takes place through a REST framework. The REST call for the photo uploading is a POST method using the Multipart media type to the URL http://toss.myphotos.cc:18081/photoUpload/.The communication between the photo service and the API abstraction program is implemented over sockets.

The interaction between the Android and the Jersey photo service uses JSON for the code validation function. The photo uploading function uses Multipart data, consisting of an InputStream to contain the photo data, a FormDataContentDisposition object containing the file details, and a String with the EventID. JSON was chosen due to its simple nature and widespread usage. Multipart is used largely because nothing else we tried was successful. Multipart was the most commonly-used method of transmitting files, but it was not trivial to implement. We had been attempting to convert the image to a byte array and send it via JSON, but the connection timed out. Fortunately, Greg discovered how to use Multiparts.

Maven dependencies included in the Jersey photo service:

Artifact ID	Group ID
• jersey-container-grizzly2-http	(org.glassfish.jersey.containers)
• jersey-media-multipart	(org.glassfish.jersey.media)
• commons-io	(org.apache.commons)
• json	(org.json)
• mysql-connector-java	(mysql)
• org.apache.commons.codec	(org.apache.directory.studio)
• junit	(junit)

API Abstraction Layer

As has been previously mentioned, TOSS allows users to store photos in one of two services, Dropbox or an FTP server. Java was chosen for implementing this functionality for two reasons. First, and perhaps most importantly, it is well understood by Josh, who is responsible for the API abstraction. Second, Java remains in prolific use. Most of the locations where we will be storing photos have a Java API.

Originally the API abstraction was to be written using the Jersey/Java photo service. However, as we did more research into what specific API's required to function properly, we found that, when it came to the API abstraction layer specifically, the Jersey/Java service was wholly unnecessary -- in other words it would be easier to implement the abstraction layer entirely in Java.

We decided to implement Dropbox first, primarily for practical reasons. Because the APIs we intend on using change so quickly, the documentation needed to properly integrate these programs into TOSS fail to keep up. As a result, figuring which puzzle piece goes where can be a Sisyphean effort. Dropbox, however, was the exception which proved the rule. We wanted to get a basic version of TOSS working as quickly as possible, and Dropbox provided well written and easily comprehensible documentation for our purposes.

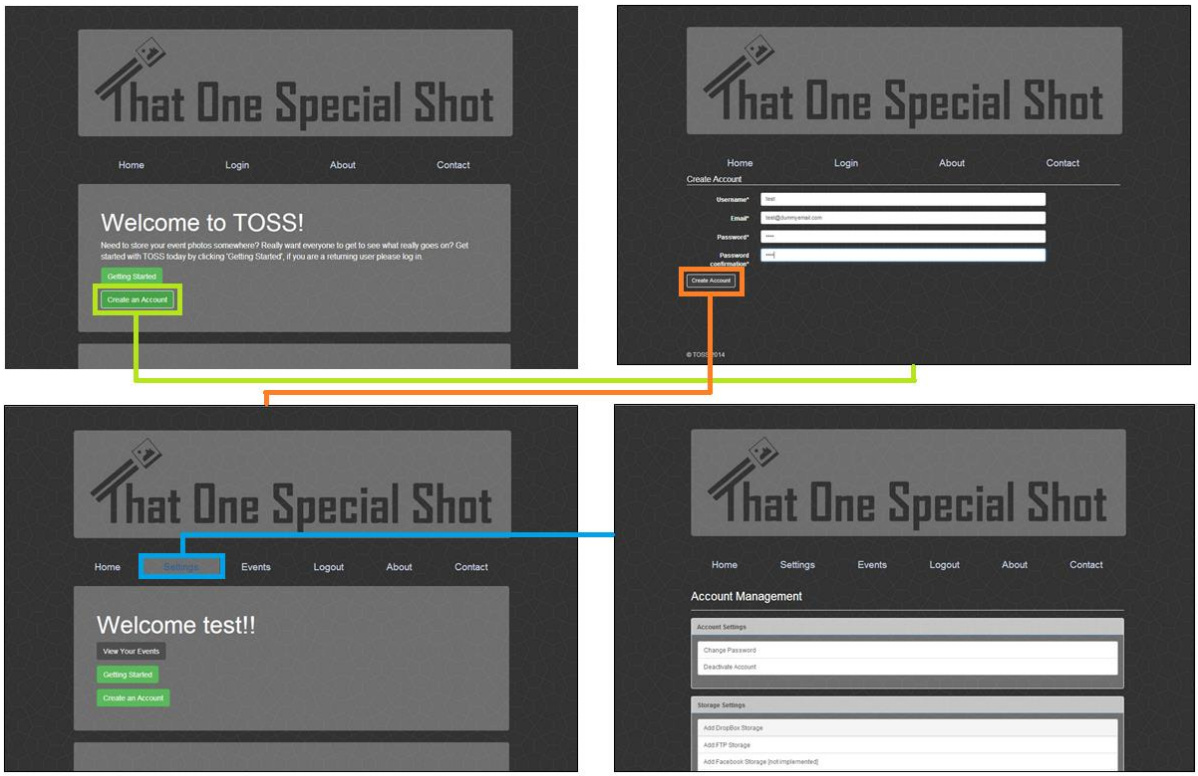
The photo to be uploaded is passed to the API abstraction layer through a socket using a TossObject, a class shared by both Patrick and Josh. A TossObject contains several pieces of pertinent information useful for uploading the photo. It contains the device id of the device which is attempting to upload the file; the event ID, which will determine, among other things, where the photo is to be stored; a photo comment to be attached to the photo; a photo's tags; and, lastly, a byte array representation of the photo which can be turned into an InputStream for the Dropbox API upon upload.

Patrick will pass Josh a TossObject through a server socket Josh will create. Josh wiill then extract the information from the TossObject, interpret it, and send the photo where it needs to go.

Web Service

The web service is implemented with Django, Nginx, and Gunicorn.

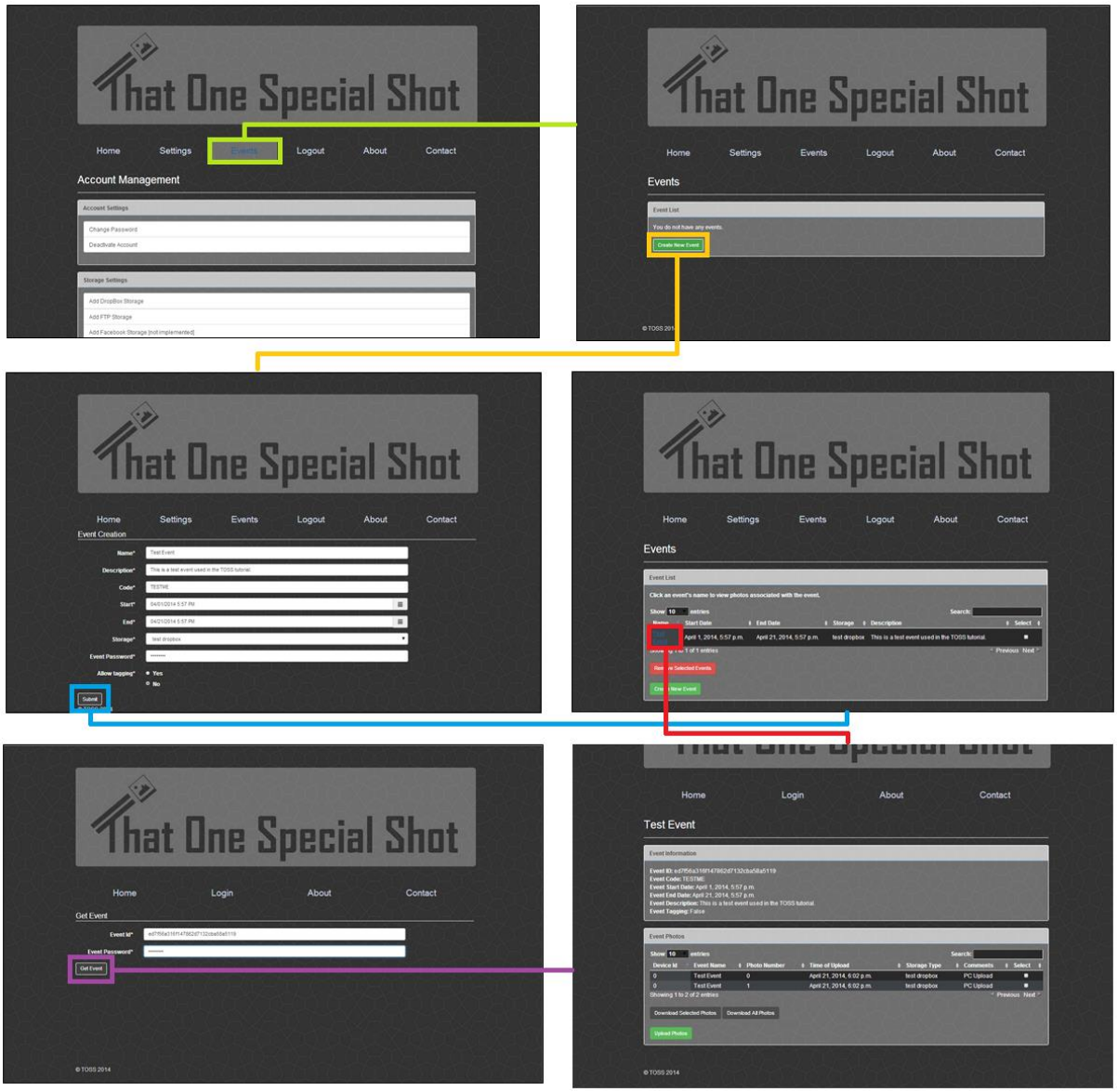
- Django is a formidable web display engine which has been proven to be effective in very large implementations which scale from single person websites to the largest of newsrooms which have constant updating documents and display them in real time to their massive userbases.
    - This engine was chosen for its ability to scale and its simplicity of implementation. Additionally, having a moderate expert in Django makes it something that was an obvious choice for our team. There is no reason for us to choose less secure and more complicated environments when we have something that works well and is well known and documented.
- Nginx is a premier content management system. It handles the presentation of information, images, content, etc to the user. Nginx very carefully handles the control of url access and flow redirecting the user as needed and making the web service as secure as possible from actual file access.
    - Easy implementation with Django and built in security makes it the obvious choice.
- Gunicorn (Green Unicorn) was chosen as a scalable web engine which has good interactions with Django and large precedence.
    - Apache tends to not work as well with scalable Django applications which made us lean more towards Gunicorn for doing the implementation we desired.



Web Service: Account System Flow

User Accounts

The web service will require users who want to create events to create a user account with our service. They will be directed to a form prompting them for a username, which must be unique in our database, an email, which must follow valid email format, a password, and a password confirmation, to avoid typos. A new user entry in the Users table in the database will be created. The user's unique username will serve as a key. The username will be tied to all events they have created as well as any APIs they have added to their account. An existing user will be able to login and logout of our web service. They will also be able to do basic account tasks like add APIs, change passwords, and deactivate their account. A logged in user will have access to all of the events they've created and all their corresponding photos without being prompted for the event id and event password unlike users who are not logged in.



Web Service: Event System Flow

Events and Event Codes

The web interface allows for users, who are registered within our site, to add storage locations for their photos and then create events which allow other users to upload photos during a time frame to those locations. In the photo above, the second image to the left is the event creation form. In this form you are automatically given a list of all added API points to select from, the ability to choose your own event code, and set a password for the event. Event codes are first come, first serve, and expiring codes. This process was chosen as a simple interface for hosts of all demographics to be able to create in a simple manner which follows an intuitive flow.

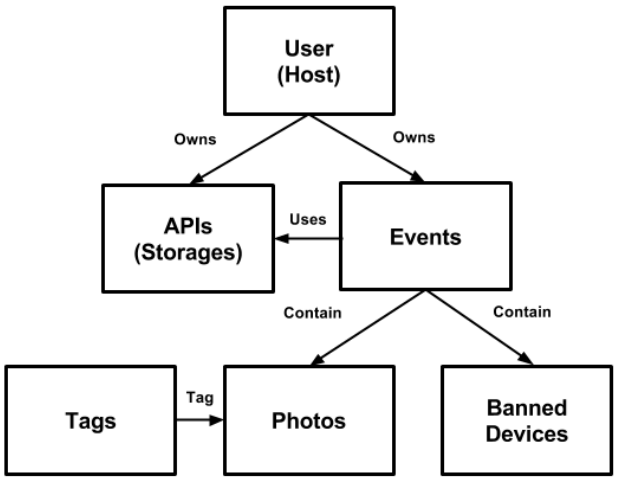
Photo Retrieval

The web service will provide photo retrieval capabilities to both users who have accounts as well as those who do not. Users who have accounts and are logged in to the service will be able to access all photos of their own events. Those who do not have user accounts or are not the host of

that event, guests, will be able to look up an event and corresponding photos using the event id and event password provided to them by the event host. With valid ids and passwords they will have access to that event's information like name, description, and photos. The web service will interact with the API abstraction layer to retrieve the photos from their corresponding storages to allow users to download photos.

Website Front-end

We used bootstrap as a base for our website front-end. Bootstrap contains HTML and CSS-based design templates for typography, forms, buttons, and interface components as well as java extensions. The advantage of using bootstrap is its compatibility with the latest versions of all major browsers. Bootstrap is modular and consists essentially of a series of less stylesheets that implement the various components of the bootstrap toolkit. A stylesheet called bootstrap.less includes the components stylesheets. Developers can adapt the Bootstrap file itself, selecting the components they wish to use in their project. There are a wide variety of features such as fonts, backgrounds, tables, headings and so on. In addition to the regular HTML elements, Bootstrap contains other commonly used interface elements. These include buttons with advanced features like grouping of buttons or buttons with drop-down options, make and navigation lists, horizontal and vertical tabs, navigation, breadcrumb navigation, pagination, etc., labels, advanced typographic capabilities, thumbnails, warning messages and progress bars.



Simplified Database Schema

Database

Mysql was chosen as our Database Backend for its well documented and well implemented history. We chose to proceed with this DB as a result of its inclusion in all versions of Python and Java as well as its security and scalability. Various other DBs were examined such as CouchDB but our lack of knowledge in them led us to choose a sql which is well known.

Our schema is a simple 6-7 table implementation which, while possible to expand, is quite complete in its current form. We use an events table to store all events, an API table to store each API the user adds and can use for an event, a photo table to store all the photos that are added, and a user table for all the users. Additionally, there are various Django built in tables.

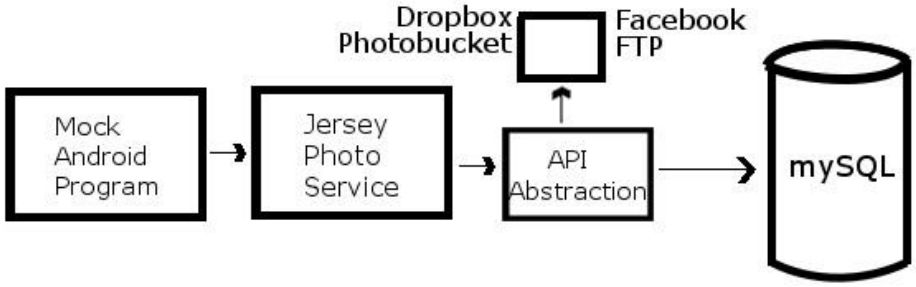
3.3 Approach for design validation

The validation and testing procedures focus more on component integration for this stage of project. Stress testing the connections between modules is critical. Notable areas of the project are:

- Android application and Jersey photo service (REST)
- Jersey photo service and Java API Abstraction (sockets)
- Jersey photo service and mySQL database
- Java API Abstraction and mySQL database
- Java API Abstraction and the various APIs (Dropbox, Facebook, FTP server)
- Web service front end (Django) and mySQL database

Each of these areas is important to the overall functioning of the system. The Android application needs to be able to communicate with the Jersey service quickly even under high loads. The Jersey service needs to be able to send the photo information quickly and without error to the API layer. The API layer needs to be able to upload the photos to the various storage mediums without delay. A large buildup of photos stored in memory while waiting for Dropbox to handle our request could cause the server to start using swap, slowing down all the programs running on the server. The API layer also needs to be able to update the information (photo location) stored in the database. This information will be being retrieved by the Django web service at regular time intervals to update the frontend gallery and slideshow. The Django web service should be less critical than the more internal components of the system, since it can be assumed that the majority of users will not be excitedly hitting the F5 key to refresh the event's photos. However, almost all users will be using the internal parts of the system (Android app, Jersey service, API, and database).

There are two main ways to test the integrity of the overall system. Either we could have a chain of tests running, where the data from the beginning (mock Android program) is the same data that is being sent from the Jersey service to the API, from the API to the storage mediums (Dropbox), and all database interactions along the way. Since many of these component share resources on the same system, it may be beneficial to test them concurrently.



Stress Test Flow

This illustration shows a comprehensive stress-test of the system. Dummy images are sent from the mock Android program to the Jersey service, which are then relayed to the API, which is sent to Dropbox. The resulting location is stored in the database. Not shown are the connections between the Jersey service and the mySQL database or the Django frontend.

Alternatively (or perhaps additionally), each connection between components could be individually stress-tested. The connection between the image-spewing mock-up and the Jersey service could be tested and evaluated before moving on to the extreme socket testing between the Jersey photo service and the API program, and so on.

Stress testing for the REST framework between the Android and Jersey service could be simulated using a mock program to rapidly toss large numbers of images to the Jersey service through REST and

Multipart. This test program could play the part of the Android phone, mimicking the actions of a thousand simultaneous TOSS users.

The Android application will need to be stress-tested by itself. Is it capable of submitting a hundred queued photos to the Jersey service? Will the app crash or slow down? Will the photos reach their destination? Will we receive a broken pipe error or timeout?

The sockets between the Jersey service and the API abstraction could be tested individually by having the Jersey service spam large numbers of InputStreams very rapidly through the socket. Ensuring that the socket does not break under the load is important. Perhaps even more important would be to implement a 'self-healing' socket implementation. If the connection between Jersey and the API Abstraction is lost, the programs need to be able to detect that and automatically set the socket back up. Human intervention each time the service breaks would take far too long.

The limits of the various APIs need to be explored a little more carefully. Meticulous research would probably be more appropriate than spamming Dropbox with a thousand photos a minute before knowing their policies. In order to determine whether or not an online storage medium will meet our requirements, we should see if limits exist on data sent, calls made, or frequency of calls. Once we are sure of the official policies of these services, we can begin stress-testing the relationship between the API Abstraction and the various storage mediums.

Testing the database interactions could be done by having the API program quickly populating a dummy table of photo information. The efficiency of this interaction could be measured by accuracy (was everything stored properly), memory usage (both peak and average) and cpu usage (peak and average).

It would probably be best to test each area individually, making sure we are within limits for each connection between components. Once we are confident in the paired performance of our different modules, we can test the system as a whole, using the same mock data for each stage.

4 Implementation notes

Android Application

Services

The Android app uses services for both event code validation and photo uploading since both consist of making REST calls to the photo service. The reason for this is that Android cannot perform networking activities on the main thread since the main thread handles the UI. This would cause the UI to freeze while performing our REST operations. To start the validation service we send an Intent to it with a reference to the object that will receive the result of the validation and the event code to be validated.

```
final Intent intent = new Intent( Intent.ACTION_SYNC, null, activity,
ValidateEventCodeService.class);
intent.putExtra(com.toss.rest.photocaptureapp.Defines.RECEIVER_KEY,
mRESTResultReceiver);
intent.putExtra( com.toss.rest.photocaptureapp.Defines.EVENT_CODE_KEY, strEventCode );
activity.startService(intent);
```

When a service is started in this way it will automatically run in a separate thread which will satisfy our requirement. Similarly for the photo upload service we start it with the following intent.

```
final Intent intent = new Intent( Intent.ACTION_SYNC, null, getApplicationContext(),
PhotoUploadService.class);
```

```
intent.putExtra(com.toss.rest.photocaptureapp.Defines.RECEIVER_KEY, mRESTResultReceiver
);
intent.putExtra( com.toss.rest.photocaptureapp.Defines.EVENT_ID_KEY,
m_EventMgr.GetPrimaryEventID() );
intent.putExtra( com.toss.rest.photocaptureapp.Defines.PHOTO_PATH_KEY, strPhotoPath);
intent.putExtra( com.toss.rest.photocaptureapp.Defines.COMMENTS_KEY, strComments);
intent.putExtra( com.toss.rest.photocaptureapp.Defines.TAGS_KEY, aTags);
startService(intent);
```

In this Intent we pass along the object that will receive the result of the photo upload, the event id to which the photo belongs, the path to the photo stored on the phone, any comments entered by the user and a list of tags that were optionally added by the user. The service must implement the onHandleIntent function in order to extract the data from the Intent.

```
protected void onHandleIntent(Intent intent);
```

The RESTResultReceiver referenced in both of the previous examples is actually an interface which is implemented by the callers of the services. The implementor must implement the following function which allows it to receive the result from the service.

```
protected void onReceiveResult(int resultCode, Bundle resultData);
```

The resultCode is a user defined code to indicate the if there were any problems while running the service and the Bundle is a mapping of Strings to values that are returned by the service.

Android Code Validation Service

In order to perform the REST calls from an Android device we used an already developed framework call Spring. In order to use this framework we need what is called a RestTemplate. The RestTemplate contains information on how to process the messages that will be sent. In the case of code validation we must add a String message converter to the template. That way any message received using the template can be translated into a String.

```
m_RestTemplate = new RestTemplate();
// Add the String message converter
m_RestTemplate.getMessageConverters().add(new StringHttpMessageConverter());
```

We can then use the template to perform a GET REST call and format the result as a String. The photo service contains a special URL “/validationService/{eventCode}” that will return a JSON representation of the event with the corresponding event code as a String.

```
// Create the url to the validation service
String strUrl = Defines.BASE_URI + "validationService/" + strEventCode;
String strResult = "";
try
{
	// Make the HTTP GET request, marshaling the response as a String object
	strResult = m_RestTemplate.getForObject( strUrl, String.class, "");
}
catch( RestClientException e)
{
	strResult = "failed connection";
}
```

The String result is converted into a JSON object which allows us to extract each attribute of the event. These attributes are then packaged into a Bundle and returned. The caller of the service which implemented RESTResultReceiver will be able to pull the information from the Bundle and do use it to join the event or inform the user that the code was invalid.

Android Photo Upload Service

In performing a photo upload we send with each picture a unique identifier for the phone or device uploading the photo. This unique identifier is achieved by using the TelephonyManager which returns a unique identifier if the device is a phone. However, if the device is not a phone then we use the slightly less reliable way by getting the Serial number of the device. The Serial number is less reliable because some manufacturers do not include the Serial number of the device in the software of the phone.

```
final TelephonyManager tm = (TelephonyManager)
getBaseContext().getSystemService(Context.TELEPHONY_SERVICE);
// use a device ID, but these are only available on devices with telephony hardware
String strDeviceID = tm.getDeviceId();
// in case we are on software without telephony hardware, use the serial number
if( strDeviceID.isEmpty() )
        strDeviceID = android.os.Build.SERIAL;
```

We also extract the time from the photo and send it with the photo. This allows the photo service to simply redirect the photo and not actually need to reconstruct it. We do this by using the ExifInterface of the photo which contains all the meta data of the photo.

```
ExifInterface photoExif;
try {
        photoExif = new ExifInterface( strPhotoPath );
} catch (IOException e1) {
        e1.printStackTrace();
        return;
}
String strDateTime = photoExif.getAttribute( ExifInterface.TAG_DATETIME );
```

To transfer the photo we must create a stream out of the photo so we do that by converting the photo to a FileSystemResource which is from the Spring framework and is similar to an InputStream.

```
FileSystemResource file = new FileSystemResource(strPhotoPath);
```

We cannot pass ArrayLists through REST since it is a Java specific structure so we convert the list of tags to a string delimited by "|".

```
// convert the list of tags to a string where the tags are seperated by a |
String strTags = aTags.size() > 0 ? StringUtils.collectionToDelimitedString( aTags,
"|") : "";
```

In order to create a Multi-part to send we will use a LinkedMultiValueMap which is from the Spring framework and allows us to add items with a mapping from a String key to the data regardless of type. So we will place the file, comments, tags, device id and photo time into the map.

```
// create a multi-part map that will contain all the data and be sent to the server
MultiValueMap<String, Object> parts = new LinkedMultiValueMap<String, Object>();
```

Similarly to the Code Validation Service we use a RestTemplate however we need to add an additional Message Converter for Multi-part form data since that is the format we use for sending the photo data to the server. This will allow Spring to convert our map to http.

```
m_RestTemplate = new RestTemplate();
// Add the String and Form(multi-part) message converter
m_RestTemplate.getMessageConverters().add(new StringHttpMessageConverter());
m_RestTemplate.getMessageConverters().add(new FormHttpMessageConverter());
```

We can then use the template to perform a POST REST call to the special photo upload Url "/photoUpload/". This will return a status that will determine if the upload was a success or if it failed and the reason why it failed. During testing a bug arose where the first photo sent after joining an event would fail due to a "Broken Pipe," researching the problem showed that it was an issue in the current Spring framework. Due to time constraints we simply created a fix until the problem is resolved in the framework. We will continue to attempt to send the photo if the POST fails due to a ResourceAccessAcception which is a "Broken Pipe."

```
// the status of the photo upload
String strStatus = "";

boolean bAttemptSend = true;
while( bAttemptSend )
{
	try
	{
		// Make the HTTP POST request
		strStatus = m_RestTemplate.postForObject(m_strUrl, parts, String.class
);
		bAttemptSend = false;
	}
	catch( ResourceAccessException e)
	{
		// Need to retry, for some reason the first attempt at sending a photo
		to
		// the socket
		// will throw this exception. Determined that it is a issue with the
		Spring
		// Framework
	}
	catch( Exception e)
	{
		// failed to upload the image
		strStatus = "failure";
		bAttemptSend = false;
	}
}
```

We create an empty bundle and return it with a result code based on the status returned by the POST. The caller of the service which implemented RESTResultReceiver will be able to use the result code to inform the user if there was a problem.

Photo Review Grid

In order to show the photos that were taken in review mode we needed to create a grid view with photo thumbnails with a checkbox on each of them. We accomplished this by using a GridView with a custom Adapter which will draw an image with a checkbox for each item in the grid.

```
m_adapter = new ImageAdapter(this);
m_adapter.SetImageList( m_aPhotoPaths );
GridView gridview = (GridView) findViewById(R.id.viewPhotoGrid);
gridview.setAdapter( m_adapter );
```

The adapter is used to grab an element for each item in the grid. In our case we use a custom object that contains a photo and a checkbox. When the Adapter is queried for an item it creates a SelectableImage which is our image checkbox combination if it does not exist. We also create click listeners for both the photo and the checkbox. Clicking on the photo will take the user to the photo edit screen so they can make changes. Clicking on the checkbox will select/unselect the photo. The code for this function is provided below.

```
// create a new ImageView for each item referenced by the Adapter
public View getView(int position, View convertView, ViewGroup parent)
{
        SelectableImage imageControl;
       if (convertView == null)
        {  // if it's not recycled, initialize some attributes
        // Create the new Selectable image
        imageControl = new SelectableImage();
                convertView = mInflater.inflate( R.layout.photo_review_item, null);
                imageControl.imageview = (ImageView)
                convertView.findViewById(R.id.thumbImage);
                imageControl.checkbox = (CheckBox)
                convertView.findViewById(R.id.itemCheckBox);

            // Add the image to the list
            if( position >= m_aImages.size() )
            {
                // fill in images until the the size is equal to the position
                for( int i = m_aImages.size(); i < position; i++)
                        m_aImages.add( new SelectableImage() );
            }
            m_aImages.add( position, imageControl);

            convertView.setTag(imageControl);

        } else {
        imageControl = (SelectableImage) convertView.getTag();
        }
        imageControl.checkbox.setId(position);
        imageControl.imageview.setId(position);
        imageControl.checkbox.setOnClickListener(new OnClickListener() {
            public void onClick(View v) {
                CheckBox cb = (CheckBox) v;
                int id = cb.getId();

                // set the check and set internal selection flag
                m_aImages.get( id ).SetSelected( !m_aImages.get( id ).IsSelected() );
                cb.setChecked( m_aImages.get( id ).IsSelected() );

                //inform review activity that photo selected
                m_pReviewActivity.SelectPhoto( m_aImagePaths.get( id ), m_aImages.get(
                id
                        ) .IsSelected() );
                }
        });
        imageControl.imageview.setOnClickListener(new OnClickListener() {
```

```
            public void onClick(View v) {
                int id = v.getId();

                m_nCurrentIDEditing = id;

                  // Open the edit screen with the thumbnail link
                Intent intent = new Intent();
                intent.putExtra( com.toss.photocaptureapp.Defines.PHOTO_PATH_KEY,
                               m_aImagePaths.get( id ) );
                       intent.setClass( mContext, PhotoViewerActivity.class);
                       m_pReviewActivity.startActivityForResult(intent, EDIT_PHOTO );
            }
        });
               // set the image
        imageControl.imageview.setImageBitmap( getThumbnailBitmap(
                m_aImagePaths.get(position), ( m_nScreenWidth - 4 * SPACING ) / 3 ) );

        // set the state of the checkbox
        imageControl.checkbox.setChecked( imageControl.IsSelected() );
        imageControl.id = position;
        return convertView;
    }
```

Photo editing using Aviary

To allow the user the add effects to their photos we integrated the Aviary photo editor into our app. Aviary is free to use and we launch the photo editor by sending an Intent to it containing the path to the photo, the path of where to store the edited photo and and the API secret which corresponds to our app.

```
Intent intentEdit = new Intent( this, FeatherActivity.class );
intentEdit.setData( Uri.parse("file://" + m_strPhotoPath ) );
intentEdit.putExtra( Constants.EXTRA_OUTPUT, Uri.parse("file://" + m_strEditedPhotoPath
) );
intentEdit.putExtra( Constants.EXTRA_IN_API_KEY_SECRET, "e38460e3dccdb447" );
startActivityForResult( intentEdit, EDIT_PHOTO_REQUEST );
```

When the Activity returns we can determine from the returned Intent if any changes were made. If the user decides to save then we will replace the original photo with the new edited photo.

Photo Service

The Jersey/Grizzly photo service is relatively simple. The function of this service is to validate event codes and redirect photo uploading from the Android phone. This is accomplished using REST calls, multipart data for the photos, and sockets. Grizzly/Jersey were chosen for the widespread documentation, lightweight nature, and compatibility. The REST framework is of course handled by Jersey, which is hosted on the Grizzly server. The photo service runs on the URL “http://toss.myphotos.cc”, using port number 18081. The photo service as well as the API abstraction layer both use Maven as the build manager and environment. Creating the Maven project with Grizzly/Jersey already set up was simple:

```
mvn archetype:generate -DarchetypeArtifactId=jersey-quickstart-grizzly2 \
-DarchetypeGroupId=org.glassfish.jersey.archetypes -DinteractiveMode=false \
-DgroupId=com.example -DartifactId=simple-service -Dpackage=com.example \
-DarchetypeVersion=2.7
(source: https://jersey.java.net/documentation/latest/getting-started.html)
```

Maven allowed us to download and include Jar dependencies without much hassle. Simply editing the pom.xml contained at the root of the directory was sufficient to import third party libraries. Third party libraries that were included in the photo service are as follows:

- jersey-bom
- jersey-container-grizzly2-http
- jersey-media-multipart
- commons-io
- json
- mysql-connector-java
- org.apache.commons.codec
- junit

Threading in the photo service was handled by Grizzly. For each REST call that connects to the service, Grizzly will spawn a new thread to handle the request. This allows the photo service to operate even under a relatively heavy load.

The validation service is a REST function that will take in a single six-character event code, check to make sure the event is valid, and return the relevant information to the Android phone in a JSON format. The requirements for event validity are:

- Event code must correspond to an existing event
- Event must have already started (current time > start of event)
- Event must not have ended (current time < end of event)
- Event must not be disabled ('disabled' is a flag contained within the toss_event database table)

If the validation of the event code was successful, the REST service will return a JSON object containing the event code, event ID, event start time, event end time, event name, whether tagging is enabled or not, and a return code. The return code is added to the JSON regardless of the success of the database query. The database querying code used for both the photo service and API layer was provided by Greg.

```
JSONObject obj=new JSONObject();
if ((querySuccess || inCache) && !outOfTime && !disabled) {
    obj.put("EventCode", eventCode);
    obj.put("ReturnCode", new Integer(100));
    obj.put("EventID", eventID);
    obj.put("EventStartTime",new Long(eventTimeStart.getTime()));
    obj.put("EventEndTime",new Long(eventTimeEnd.getTime()));
    obj.put("EventName",eventName);
    obj.put("TaggingEnabled", taggingMode);
} else {
    obj.put("ReturnCode", new Integer(200));
}
```

JSON return code for validation REST call
Note: All code snippets will be screenshots, as syntax highlighting may be seen.

In order to reduce the amount of calls the photo service made to the database, Greg and I decided to implement a caching system for event validation. The caching system currently holds 100 different events in memory before recycling space in the caching map and queue. If the event being requested is in the queue map, the photo service will simply return a JSON of the in-memory CacheObject (after making the necessary time/disabled checks, of course). If the event is not in the cache, the photo service will query the database for the relevant information, create a CacheObject, insert it into the cache map and queue, and return to the user the retrieved event information. If the number of events in memory plus the current

event exceed the cap (final variable set at 100), the program will clear the oldest event from memory after inserting the new event. The program will periodically iterate through the event map and cache, looking for events that have expired, and remove them.

```
if (!inCache || outOfTime) {
    try {
        ResultSet set = Main.sql.PerformQuery(selectList, fromList, "code =
        if (set.next()) {
            eventName = set.getString("name");
            eventID = set.getString("id");
            eventTimeStart = set.getTimestamp("start");
            eventTimeEnd = set.getTimestamp("end");
            taggingMode = set.getBoolean("tags");
            disabled = set.getBoolean("disabled");
            querySuccess = true;

            // create new cacheEvent object and put it in the hashmap
            System.out.println("time start: " + eventTimeStart.getTime());
            System.out.println("time end: " + eventTimeEnd.getTime());
            System.out.println("time: " + System.currentTimeMillis());
            if (eventTimeEnd.getTime() > System.currentTimeMillis() && even
                CacheEvent cacheObject = new CacheEvent(eventCode, eventID,
                Main.cacheMap.put(eventCode, cacheObject);
                Main.cacheQueue.add(eventCode);
            } else outOfTime = true;

        }
        Main.sql.close();
    } catch (Exception e) {
        e.printStackTrace();
    }

}
```

Part of the caching code. In this snippet, the logic detailing database querying and cache insertion is shown.

Overall, the cache speeds up the performance of event validation in the photo service, at a slight cost to memory. In my opinion, the cache was more trouble than it was worth. The greatest cost related to implementing this cache was managing the code. Many bugs had an opportunity to hide in this feature of the photo service, and while it performed well and served its purpose, the complexity it added to Resource.java was rather frightening.

Photo uploading via the Android app was handled via the "/photoUpload" REST call. Multipart Form Data was used to transmit the image from the phone to the REST server. Figuring out how to actually get the Multiparts working was one of the most difficult parts of the photo service.

```
@POST
@Path("/photoUpload")
@Consumes(MediaType.MULTIPART_FORM_DATA)
public Response gregUpload(
        @FormDataParam("PhotoData") InputStream uploadedInputStream,
        @FormDataParam("PhotoData") FormDataContentDisposition fileDetail,
        @FormDataParam("EventID") String strEventID,
        @FormDataParam("PhotoComments") String strPhotoComments,
        @FormDataParam("PhotoTags") String strPhotoTags,
        @FormDataParam("DeviceID") String strDeviceID,
        @FormDataParam("PhotoTime") String strPhotoTime) {
```

Alien-looking Multipart REST call definition.

We had originally tried many different forms of Media types, such as Base64 strings as plain text and JSON formats. These would usually result in a timeout condition, which would break a pipe on the Android App, crashing it. The only Media type that performed well were Multiparts.

One of the steps of implementing the Multipart code (in addition to the unintuitive method declaration) was to register the MultiPartFeature class within the ResourceConfig of the Grizzly server. That was truly unintuitive, as many of the Multipart tutorials assumed intrinsic knowledge concerning the relationship between ResourceConfig and Multipart.

Checks within the photo upload method are:

- Is the user banned? If yes, disallow his photo to be uploaded
- Is the socket connected to the API layer functional?
- Is the output stream associated with the socket non-null?

Once the photo service had received a Multipart, it would send the picture data across the socket to the API layer. The serialization of this data used Java's ObjectOutputStream and a custom-made class, known as TossObject. The TossObject class held the picture data in a byte array, which the API layer would then use to upload to the relevant storage medium.

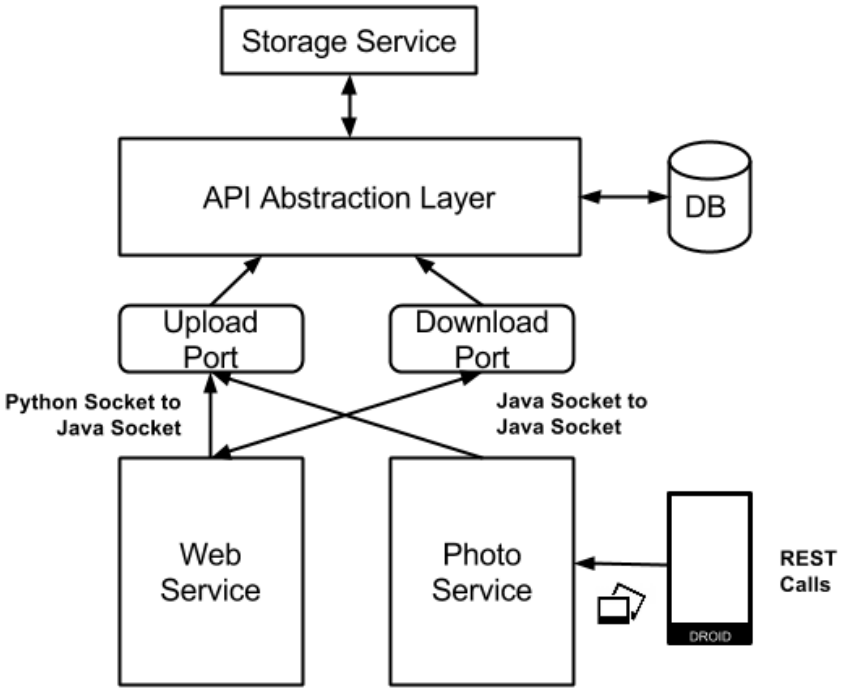
I ran into an interesting scenario while implementing the ObjectOutputStream between the photo service and the API layer: Java requires that the serialized class definition be exactly the same on one side as the other. Simply having identical text would not cut it. Java would complain about mismatched objects while attempting to send the serialized TossObject across the ObjectOutputStream. The solution suggested by Zach worked well. He suggested using symlinks. Symbolic linking TossObject.java between the photo service and the API layer worked well. Originally, I naively made the symlink an absolute path, which broke for Greg when he pulled the latest changes. Fixing the symlink to a relative path fixed the problem. Java must use a hash for each class file it compiles and compares them against objects coming in across the ObjectOutputStream.

```
if (!isDeviceBanned) {
    try {
        if (Main.socket != null) {
            outStream = Main.socket.getOutputStream();
        }
        if (outStream == null) {
            System.out.println("API SOCKET OUT STREAM is *NULL*!!!");
            System.out.println("Is the PhotoService connected to the API Layer??");
        } else {
            objStream = new ObjectOutputStream(outStream);

            // convert tag string to a list delimited by "|"
            ArrayList<String> taglist = new ArrayList<String>();
            String[] aTags = strPhotoTags.split("[|]");
            for( String strTag : aTags ) {
                taglist.add( strTag );
            }

            System.out.println("EventID: " + strEventID);
            System.out.println("DeviceID: " + strDeviceID);
            System.out.println("PhotoTime: " + strPhotoTime);
            TossObject toss = new TossObject(strDeviceID, strEventID, strPhotoCommen
            objStream.writeObject(toss);
        }

    } catch (Exception e) {
        e.printStackTrace();
        retval = "failure";
    }
}
```

TossObject serialization. Photo service to API layer.

The socket used between the photo service and the API layer runs on port 9090 and connects during the service start-up. This means that the API layer service must already be running before the photo service is started. I had originally planned to implement a 'heartbeat' between the two services, which would remove the start-up order dependency and would solve broken socket issues during runtime. However, due to a time shortage as well as a fear that more bugs would be introduced during heartbeat development, this feature was not implemented.

API Abstraction Layer



API Abstraction Layer - Web Service - Photo Service Communication

API Abstraction Layer

Conceptually, the API Abstraction Layer functions as a bridge, though what it connects depends on how it is used. During uploading the abstraction layer bridges the gap between Patrick's Photo Service and where the photos are to be stored. During download, it works as a bridge between the Web Service and where the photos are already stored. Before the API Abstraction Layer's functionality can be discussed, we must discuss two things: TOSS Objects and TOSS Threads.

TOSS Object

TOSS Objects are the primary way the Photo Service interacts with the abstraction layer. A TOSS Objects only contains fields and a constructor with which to initialize those fields. Unlike most classes, helper methods are not required here. The TOSS Object is merely a repository of information. It will not need to manipulate information in any way.

Fields

A TOSS Object contains five fields. The first three are strings, which store the Device ID of the device which uploaded the photo; the validated Event ID which will determine where the photo needs to be stored; and a photo comment, a brief block of text users can add to their photos. The fourth field is an ArrayList of Strings which stores the different tags the user may have added to the photo.

The fifth is a byte array which contains the photo to be uploaded. Initially this field was of type InputStream. An InputStream is a Java class which facilitates the reading of bytes from various locations.

An InputStream was the initial choice for how to store the photo for three reasons: First, they are easy to create. Second, InputStreams tend to both be straightforward and powerful). Last, and most important, both the Dropbox and FTP APIs require InputStreams to upload a photo.

However, a problem occurred during the first round of testing (before I provided Patrick with the TOSS Object code). The Photo Service passes the TOSS Object to the API Abstraction Layer via a socket. To do this, the socket uses what is called an ObjectOutputStream. (Where a subclass of InputStream designates a location to be read from, a subclass of OutputStream designates a location to be written to.) As I discovered during testing, it is impossible to pass an object of type InputStream through an OutputStream, so a new method had to be devised.

Constructor

Initializing the first four fields was straight forward: parameters corresponding to each field were placed in the constructor's declaration. When the constructor is called, the four fields are immediately set equivalent to the constructor's parameters. However, by this point in the project, the Photo Service was already creating InputStreams to send the API Abstraction Layer, so I did not want to change the constructor of the TOSS Object, which asks for an InputStream representation of a file.

Because using an InputStream would not work, it was determined that the TOSS Object should store the photo using a byte array. Initializing the byte array at first proved difficult. While InputStreams contain methods for reading all the information from a file into a single byte array, for these methods to work we would have to know at compile time the exact number of bytes that are to be read. This is, of course, is something which cannot be determined. However, the class ByteArrayOutputStream does have a method, toByteArray(), which returns a byte Array representation of bytes which will later to be written to some other locations.

Realizing this, we came up with a new, slightly convolute) plan. The class TOSS Object would accept an InputStream as a representation of a photo. That InputStream would then be changed into a ByteArrayOutputStream using the IOUtils.copy(InputStream, OutputStream) function, found in the Apache Commons IO library. Afterward, the ByteArrayOutputStream would be used to initialize the TOSS Object's byte array with its, toByteArray() method. The relevant code is shown below.

For clarity, lines not specifically pertinent to the initialization of the byte array have been omitted.

```
import org.apache.commons.io.IOUtils;
public class TossObject implements Serializable{
              public byte [] byteArray;
public   TossObject   (String   device,   String   event,   String   comment,
ArrayList<String> tags, InputStream inputStream){
             ByteArrayOutputStream output = new ByteArrayOutputStream();
             IOUtils.copy(inputStream, output);
             byteArray = output.toByteArray();
       }
}
```

TOSS Thread

In order to handle multiple photos for multiple events in real time, the API Abstraction Layer uses Java threads. When the abstraction layer receives a TOSS Object though the upload socket, it immediately passes the TOSS Object to a thread; that thread will upload the photo stored in the TOSS's byteArray field to either Dropbox or an FTP server.

The TOSS Thread constructor has one parameter, which accepts a TOSS Object. Two things happen when this constructor is called. First, the TOSS Object is copied locally. Second, a ByteArrayInputStream is created using the byteArray stored in the TOSS Object. As has previously been mentioned, an InputStream (or a subclass of InputStream) is needed to upload files to Dropbox or the FTP server.

The thread's run method (which initiates the thread) is incredibly simple. First, it retrieves the Event ID stored in the TOSS Object. Second, it looks up the Event ID in the cache or (failing that) the MySQL database to determine where the photo should be stored. Last, it uploads the photo to either Dropbox or the FTP client.

DbxException.RetryLater

When multiple photos are uploaded to Dropbox very quickly, the server can become overloaded. When this occurs, the code which uploads the photo to Dropbox will through an exception of type DbxException.RetryLater. When this occurs, the only solution is to wait a length of time and try again. After contacting the Dropbox developer team for some advice, it was determined that the amount of time the code should delay between uploads should increase exponentially. This is done using the following code.

```
public int delay  = 2;
final long delayExponent = 2;

public void handleDbxException(DbxException ex){
         if(ex instanceof DbxException.RetryLater){
                System.out.println("Retry Later.");
                delay = (int) Math.pow(delay, delayExponent);
                Delay(delay);
                ();
                }
         }

public void Delay(long time){
        System.out.println("Delay: " + time + " milliseconds");
        Thread.sleep(time);
}
```

When the file has been successfully uploaded to Dropbox, delay is reset to two.

ZipItUp

The final piece of the API Abstraction Layer is the ZipItUp class, which facilities the downloading of files from Dropbox and FTP clients. There are three functions of importance here, downloadFiles64(), downloadFiles(), and addToZip(). DownloadFiles64() is a method used to download all the files from a client. To do this, it first passes the client to the to the overloaded downloadFiles() method. If downloadFiles is only given a client, it will retrieve OutputStreams of all the photos stored there. If it is also given an ArrayList of Strings (where each String in the ArrayList denotes the name of the photo) it will only retrieve the OutputStreams of the specified photos . These OutputStreams are added to a Zip File using the addToZip function. Then the downloadFiles() method returns the created Zip File in the format of a byte Array.

Finally, downloadFiles64() encodes the returned byte array in base 64 so it can be read by the Web Service, which is written in Python.

For clarity, the catching of exceptions through try and catch statements are not shown.

```
private ZipOutputStream zos = null;

public byte[] downloadFiles64(DbxClient client){
       Base64 base64 = new Base64();
       byte[] byteArray = downloadFiles(client);
       byte[] encodedByteArray = base64.encodeBase64(byteArray);
       encodedByteArray;
}

public byte[] downloadFiles(DbxClient client){
       ByteArrayOutputStream outputStream = new ByteArrayOutputStream();
       zos = new ZipOutputStream(outputStream);
       DbxEntry.WithChildren listing = null;
       listing  = client.getMetadataWithChildren("/");

       for (DbxEntry child : listing.children) {
              if(!child.isFile())
                     continue;

              ByteArrayOutputStream output = new ByteArrayOutputStream();
              client.getFile('/'+child.name, null, output);
              addToZip(child.name, output);
        }

       zos.close();
       return outputStream.toByteArray();
 }

public void addToZip(String fileName, ByteArrayOutputStream file){
       ZipEntry ze = new ZipEntry(fileName);
       zos.putNextEntry(ze);
       zos.write(file.toByteArray(), 0, file.size());
       file.close();
       zos.closeEntry();
}
```

Web Service

The web service has three main responsibilities, accounts, events, and photos. The web service is built on a Django web framework. There are several important files that make up the Django framework. The ‘views.py’ contains all of the functionality of the web service, ‘models.py’ contains the Django models that build up the database, ‘forms.py’ contains all of the forms used in ‘views.py’ to retrieve structured data from the website front-end. The website front end is built using html and bootstrap css. There is a corresponding html file and corresponding Django view in ‘views.py’ for every webpage on the website. The following code snippets are an example of how the account creation web page is represented in the Django web framework. Each webpage with a form has a forms.py entry, and every webpage has an entry in view.py and html file.

forms.py

```
class UserCreationForm(forms.ModelForm):
   username = forms.CharField(max_length = 200, required=True)
   email = forms.CharField(max_length = 200, required=True, validators=
[validators.validate_email])
   password1 = forms.CharField(label='Password', widget=forms.PasswordInput)
   password2 = forms.CharField(label='Password confirmation',
widget=forms.PasswordInput)
   class Meta:
       model = User
```

```
        fields = ('username', 'email')

    def clean_password2(self):
        # Check that the two password entries match
        password1 = self.cleaned_data.get("password1")
        password2 = self.cleaned_data.get("password2")
        if password1 and password2 and password1 != password2:
            raise forms.ValidationError("Passwords don't match")
        return password2

    def save(self, commit=True):
        # Save the provided password in hashed format
        user = super(UserCreationForm, self).save(commit=False)
        user.set_password(self.cleaned_data["password1"])
        if commit:
            user.save()
        return user

    def __init__(self, *args, **kwargs):
        self.helper = FormHelper()
        self.helper.form_class = 'form-horizontal'
        self.helper.label_class = 'col-lg-2'
        self.helper.field_class = 'col-lg-8'
        self.helper.form_method = 'post'
        self.helper.form_action = 'account_creation'
        self.helper.layout = Layout(
            Fieldset(
                'Create Account',
                'username',
                'email',
                'password1',
                'password2',
            ),
            FormActions(
                Submit('submit','Create Account'),
            ),
        )
        super(UserCreationForm, self).__init__(*args, **kwargs)
```

views.py

```
def account_creation(request):
    if request.method == 'POST': #If form has been submitted
        form = UserCreationForm(request.POST)
        if form.is_valid(): # Validation rules pass
            user = form.save()
            user = authenticate()
            username = form.cleaned_data['username']
            password = form.cleaned_data['password1']
            user = authenticate(username = username, password = password)
            if user:
                django_login(request,user)
                if not request.session.exists(request.session.session_key):
                    request.session.create()
                request.session['username'] = user.username
                return HttpResponseRedirect('/account_management/') # Redirect after
POST
        return render(request, 'account_creation.html', {'form' : form}) # Redirect
after POST
    else:
```

```
        form = UserCreationForm()
    return render(request,'account_creation.html', {'form':form})
```

account_creation.html

```
{% extends "base.html" %}
{% load crispy_forms_tags %}
{% crispy form  form.helper %}
{% block content %}

{% crispy form %}
{% endblock %}
```

Accounts

The web service is responsible for creating User entries in the database that are tied to both Storage Services (APIs) and Events. Creating a user account involves a Django form, a view, and a model. The Django form is responsible for collecting structured data from the webpage and verifying the validity of the data and providing error information. The view is responsible for collecting the data and transferring it to the database as well as redirecting the user to another view upon form validation or failure.

Each Django view takes in a request parameter that contains information pertaining a users session within the website. This request parameter contains user information. If the user is an authentic user, a user registered on our site, they are allowed to view certain webpages not accessible to guest users. These access permissions are enforced by both a condition in the html that blocks certain links from appearing as well as a requirement on the corresponding views. If a user happens to bypass the html check by typing the url they are caught by the views requirement which redirects them to the login screen.

html

```
{% if user.is_authenticated %}
```

views.py

```
@login_required(login_url='/login/')
```

Data is frequently passed from one view to another using this request parameter for use in both the view and its corresponding webpage. The {% %} syntax used within the html is a Django template language used to read the data in request parameters from Django views.

The account responsibility of the web service also provides functionality for logging in and out of the web service, deactivating and reactivating their account, and changing their password. Another major aspect of accounts is Storage Services or APIs.

There are currently two types of storage services available to users, Dropbox, and FTP. The web service is responsible for collecting the data required for accessing the user's storage service account and storing it in the database. Adding a Dropbox storage requires the user to log into their Dropbox account and give our application permission to access their account, once this is done we use Dropbox's API to access their access_token. We then save a new entry in the API table of the database which stores the user, the service_name as 'dropbox' and the access_token. The FTP addition is simply another Django form that requires the user to provide us with the servers hostname, and server account information including username and password. In the forms validation we check that the information provided can actually be used to connect to the server, otherwise we fail the validation and require the user to input different information. We then save a new entry in the API table with the information collected.

FTP Validation

```
try:
    # Check that ftp connection possible
    ftp = FTP(cleaned_data.get('url'))
    ftp.login(cleaned_data.get('username'),cleaned_data.get('password'))
    ftp.quit()
 except:
    raise forms.ValidationError("The FTP credentials provided are invalid.")
```

Events

Users who have an account on our website can create an event. The form and views are similar to the ones discussed except the storage option of the form is auto-filled with the storage services connected to that user's account. After event creation the user is directed to a page which contains a list of all their events they've created which each links to a more detailed event page.

Each event has a corresponding event_view webpage whose url is 'toss.myphotos.cc/event_view/[event_id]'. Owners of these events can access these event pages through the 'Events' tab of the website. Guests can access these webpages through a form that collects the event id and the event password. The corresponding view checks the database to see if there is an event with the credentials provided and if there it is it redirects the user to that events page, if there isn't it prompts the user to input new information. If the user happens to know the format of the urls and tries to access the web page by typing in the url manually the view for that event page they are redirected back to the form to input the credentials. This is done by having the view that validates form data append an 'event_password' variable to the request that it sends to view that shows the event webpage. Within the event webpage view if this variable is not the password for that event it rejects the request and redirects it back to the form. Owners of events are able to bypass the password requirement because the view also checks if the request user is the owner of the event.

views.py

```
# View to get event with event id and password
def get_event(request):
   if request.method == 'POST':
       form = GetEventForm(request.POST)
       if form.is_valid():
           event_id = form.cleaned_data['event_id']
           event_password = form.cleaned_data['event_password']
           try:
               Event.objects.get(id = event_id, password = event_password)
               request.session['event_password'] = event_password
               return HttpResponseRedirect('/event_view/'+ event_id + '/') # Get
event page with photo information
           except Event.DoesNotExist:
               return render(request,'get_event.html', {'is_invalid': True,
'form': form})
       return render(request,'get_event.html', {'form' : form})
   else:
       form = GetEventForm()
   return render(request,'get_event.html', {'form' : form})

# View that shows the event page corresponding to id
def show_event(request, event_id):
   try:
       is_host = True
       current_event = Event.objects.get(id = event_id)
       # If user trying to access event is not the host, make sure they entered
the correct password
       if request.user != current_event.host:
```

```
            is_host = False
            if request.session['event_password'] != current_event.password:
                return HttpResponseRedirect('/get_event')
        ...
```

Photos

Each event page displays a list of the photos that are in the database that have the corresponding event id. The table is created using a jquery plug-in called DataTable. It provides the user with a clean looking interactable table. The photo_table is an html table that is populated with data from the show_event view.

event_view.html

```
<head>
   <meta http-equiv="content-type" content="text/html; charset=utf-8" />
   <style type="text/css" title="currentStyle">
       @import "{% static "css/photo_table.css" %}";
   </style>
   <script type="text/javascript" language="javascript" src="{% static
"js/jquery.js" %}"></script>
   <script type="text/javascript" language="javascript" src="{% static
"js/jquery.dataTables.js" %}"></script>
   <script type="text/javascript" charset="utf-8">
      var oTable;
       oTable = $('#photo_table').dataTable();
   </script>
</head>
…
<table cellpadding="0" cellspacing="0" border="0" class="display"
id="photo_table">
<thead>
       <tr>
              <th>Device Id</th>
              <th>Event Name</th>
              <th>Photo Number</th>
              <th>Time of Upload</th>
              <th>Storage Type</th>
              <th>Comments</th>
              <th>Select</th>
       </tr>
</thead>
<tbody>
       {% for photo in photos %}
<tr>
<td>{{photo.device_id}}</td>
       ...
```

views.py

```
# View that shows the event page corresponding to id
def show_event(request, event_id):
       ...
       return render(request,'event_view.html', {'event':current_event,
       'photos':event_photos, 'is_host':is_host, 'banned_photos':
       banned_photos})
```

If the request user is the event host then they are allowed to both ban and unban device ids, this is done by using a form to collect the checkbox data in the html file and returning it back to the view. The view then creates a new entry in the banned_devices table. Similarly if a user wants to unban a device we remove it from the table. Photos from a banned_device are still displayed to the host, with their device in red to marked banned, however these photos are not displayed to

guests. This is done by populating two different data lists in the view. The event host can see both the event_photos and banned_photos list wheras guests can only see event_photos.

Both event hosts and event guests are able to upload photos. The form for uploading photos is created using a jQuery plugin called File Upload by blueimp. The files are sent from the form to the upload view by appending them to the request FILES. For each of the files a new entry in the Photo table is created. The photo is then sent to the API abstraction layer to be added to the storage service for that event. This is done by creating a socket to connect to the API Abstraction layer on port number 9091. We send a JSON object over the socket that contains the event id, sequence number, and the photo data encoded in base 64.

upload_photos.html

```
...
<form action="upload_photos" method="POST" enctype="multipart/form-data">
{% csrf_token %}
   <div class="input-group">
       <span class="input-group-btn">
           <span class="btn btn-primary btn-file">
           Browse&hellip; <input id="fileupload" type="file"  name="files[]"
multiple>
           </span>
       </span>
           <input type="text" class="form-control" readonly>
       </span>
   </div>
   <br>
   <button type="submit" class="btn btn-primary">
       <i class="glyphicon glyphicon-upload"></i>
       <span>Upload</span>
   </button>
   <br>
   <br>
</form>
...
```

views.py

```
def upload_photos(request, event_id):
   if request.method == 'POST':
       # Connect to API Server
       hostname = 'localhost'
       api_port = 9091
       api_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
       try :
           api_socket.connect((hostname, api_port))
       except :
           print 'Unable to connect to API Abstraction'
       ...
       for photo in request.FILES.getlist('files[]'):
           # Add photo to database
           photo_name = photo.name
           new_photo = Photo (
                   device_id = '0',
                   event_id = current_event,
                   sequence_number = current_sequence_num+1,
                   time = datetime.datetime.now(),
                   storage = current_event.storage,
                   comment = 'PC Upload'
               )
           new_photo.save()
```

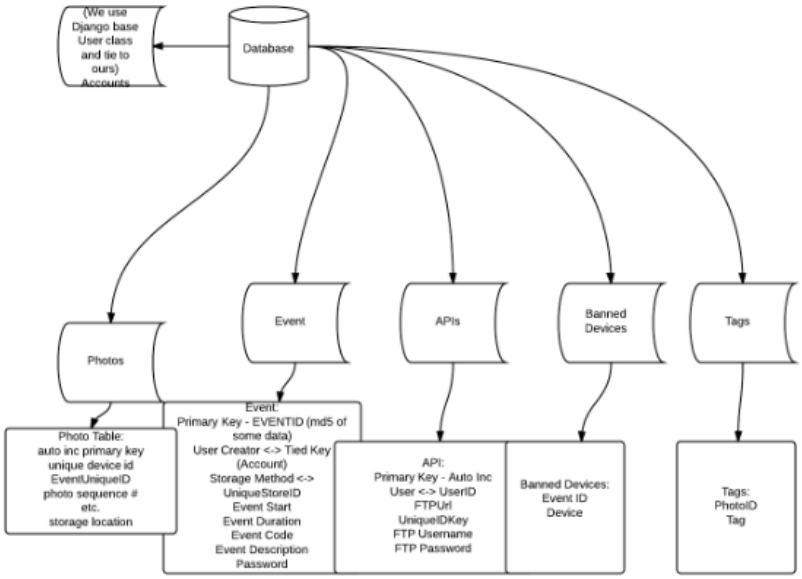
```
            current_sequence_num = current_sequence_num+1
            # Send photo to API Abstraction to upload to storage
            file_data = photo.read()
            event_id = event_id
            data = {'event_id': event_id,'sequence_number': current_sequence_num,
'photo': base64.b64encode(file_data)}
            msg = json.dumps(data)
            try:
                api_socket.send(msg +'\n')
                print 'Photo sent to API Abstraction'
            except:
                print 'Cound not send photo to API Abstraction'
        try :
            api_socket.send('CLOSE\n')
            api_socket.close()
        except :
            print 'Unable to close API Abstraction socket'
        return HttpResponseRedirect('/event_view/'+ event_id + '/')
    return render(request,'upload_photos.html')
```

Both event hosts and event guests are able to download photos. They are able to select the photos they want to download using the checkbox, or download all photos. In either case the data is sent back to the view. For the case of selectively downloading photos the photo sequence numbers are sent. In both cases the web service connects to the API Abstraction Layer with a socket to port number 9092. A JSON object is sent over the socket containing the event id and a list of selected photos, in the case of download all, the selected photos contains a list of all photos in that event. We then wait for a message back from the API abstraction layer that contains a zip file. We decode the zip file from base 64 and write the zip file to memory. The view then returns a response to the user with the zip file.

views.py

```
def show_event(request, event_id):
        ...
        msg_data = {'event_id': event_id, 'sequence_number': selected_photos}
        msg = json.dumps(msg_data)
        hostname = 'localhost'
        api_port = 9092
        api_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
        try :
             api_socket.connect((hostname, api_port))
             try:
                 api_socket.send(msg +'\n')
                 print 'Message for all photos sent to API Abstraction'
             except:
                 print 'Cound not send message to API Abstraction'
             try:
                 zip_data = api_socket.makefile()
                 print 'Photos recieved'
                 zip_file =
        base64.b64decode(zip_data.readline().replace('\n',''))
                 s = StringIO.StringIO()
                 s.write(zip_file)
                 response = HttpResponse(s.getvalue(), mimetype =
        "application/x-zip-compressed")
                 response['Content-Disposition'] = 'attachment;
        filename=TOSS_photos.zip'
                 print 'Closing socket'
                 api_socket.send('CLOSE\n')
                 api_socket.close()
```

```
            return response
        except:
            print 'Exception caught'
            traceback.print_exc(file=sys.stdout)
except :
        print 'Unable to connect to API Abstraction'
```


(We use Django base User class and tie to ours) Accounts
Database
Photos
Event
APIs
Banned Devices
Tags
Photo Table: auto inc primary key unique device id EventUniqueID photo sequence # etc. storage location
Event: Primary Key - EVENTID (md5 of some data) User Creator <-> Tied Key (Account) Storage Method <-> UniqueStoreID Event Start Event Duration Event Code Event Description Password
API: Primary Key - Auto Inc User <-> UserID FTPUrl UniqueIDKey FTP Username FTP Password
Banned Devices: Event ID Device
Tags: PhotoID Tag

Database Schema

Database

The database we used for the implementation of our project was a standard mysql database. We chose to create our database in this system for standardization as well as future proofing our system. The database is built primarily by the django/python end of the software. After the initialization of the models files the django manage.py will build the database. The models.py is created as follows:

```
BEGIN MODELS.PY{
from django.db import models
from django.contrib.auth.models import User

# Stores API with user name, access API and create new ones tied to that user
class API(models.Model):
   service_name = models.CharField(max_length=64)
   uid = models.CharField(max_length=128, null = True)
   storage_space = models.BigIntegerField()
   #These fields are specifically for ftp as they require plain text auth
   username = models.CharField(max_length = 256, null = True)
   password = models.CharField(max_length = 256, null = True)
   url = models.CharField(max_length = 256, null=True)
   user = models.ForeignKey(User)
   def __unicode__(self):
       return u'%s %s' % (self.user.username, self.service_name)

class Event(models.Model):
   id = models.CharField(max_length=32, primary_key=True)
   host = models.ForeignKey(User)
   start = models.DateTimeField()
```

```
    end = models.DateTimeField()
    storage = models.ForeignKey(API)
    code = models.CharField(max_length = 32, null = True)
    name = models.CharField(max_length = 128)
    description = models.CharField(max_length = 256)
    password = models.CharField(max_length=32)
    tags = models.BooleanField()
    disabled = models.BooleanField(default = False)
    def __unicode__(self):
        return u'%s' % (self.name)

class Banned_Devices(models.Model):
    device_id = models.CharField(max_length=128)
    event = models.ForeignKey(Event)

class Photo(models.Model):
    device_id = models.CharField(max_length=128)
    event_id = models.ForeignKey(Event)
    sequence_number = models.IntegerField()
    time = models.DateTimeField()
    comment = models.CharField(max_length = 512, blank = True)
    storage = models.ForeignKey(API)

class Tags(models.Model):
    photo = models.ForeignKey(Photo)
    tag = models.CharField(max_length = 512)

class Event_Emails(models.Model):
    event_id = models.ForeignKey(Event)
    email = models.EmailField()

}ENDMODELS.PY
```

If someone was to try and use this project without django, the create statements for SQL are shown below so that they can generate the proper structure for the application.

The following statement (BEGIN to COMMIT;) builds our entire database as is used in production.

```
BEGIN;
CREATE TABLE `toss_api` (
    `id` integer AUTO_INCREMENT NOT NULL PRIMARY KEY,
    `service_name` varchar(64) NOT NULL,
    `uid` varchar(128),
    `storage_space` bigint NOT NULL,
    `username` varchar(256),
    `password` varchar(256),
    `url` varchar(256),
    `user_id` integer NOT NULL
)
;
ALTER TABLE `toss_api` ADD CONSTRAINT `user_id_refs_id_6f1bf5ec` FOREIGN KEY
(`user_id`) REFERENCES `auth_user` (`id`);
CREATE TABLE `toss_event` (
    `id` varchar(32) NOT NULL PRIMARY KEY,
    `host_id` integer NOT NULL,
    `start` datetime NOT NULL,
    `end` datetime NOT NULL,
    `storage_id` integer NOT NULL,
    `code` varchar(32),
    `name` varchar(128) NOT NULL,
```

```
    `description` varchar(256) NOT NULL,
    `password` varchar(32) NOT NULL,
    `tags` bool NOT NULL,
    `disabled` bool NOT NULL
)
;
ALTER TABLE `toss_event` ADD CONSTRAINT `storage_id_refs_id_31c46367` FOREIGN KEY
(`storage_id`) REFERENCES `toss_api` (`id`);
ALTER TABLE `toss_event` ADD CONSTRAINT `host_id_refs_id_21e0dcd2` FOREIGN KEY
(`host_id`) REFERENCES `auth_user` (`id`);
CREATE TABLE `toss_banned_devices` (
    `id` integer AUTO_INCREMENT NOT NULL PRIMARY KEY,
    `device_id` varchar(128) NOT NULL,
    `event_id` varchar(32) NOT NULL
)
;
ALTER TABLE `toss_banned_devices` ADD CONSTRAINT `event_id_refs_id_d01a63b3` FOREIGN
KEY (`event_id`) REFERENCES `toss_event` (`id`);
CREATE TABLE `toss_photo` (
    `id` integer AUTO_INCREMENT NOT NULL PRIMARY KEY,
    `device_id` varchar(128) NOT NULL,
    `event_id_id` varchar(32) NOT NULL,
    `sequence_number` integer NOT NULL,
    `time` datetime NOT NULL,
    `comment` varchar(512) NOT NULL,
    `storage_id` integer NOT NULL
)
;
ALTER TABLE `toss_photo` ADD CONSTRAINT `storage_id_refs_id_b7ba9f6d` FOREIGN KEY
(`storage_id`) REFERENCES `toss_api` (`id`);
ALTER TABLE `toss_photo` ADD CONSTRAINT `event_id_id_refs_id_3dc33457` FOREIGN KEY
(`event_id_id`) REFERENCES `toss_event` (`id`);
CREATE TABLE `toss_tags` (
    `id` integer AUTO_INCREMENT NOT NULL PRIMARY KEY,
    `photo_id` integer NOT NULL,
    `tag` varchar(512) NOT NULL
)
;
ALTER TABLE `toss_tags` ADD CONSTRAINT `photo_id_refs_id_68985eb2` FOREIGN KEY
(`photo_id`) REFERENCES `toss_photo` (`id`);
CREATE TABLE `toss_event_emails` (
    `id` integer AUTO_INCREMENT NOT NULL PRIMARY KEY,
    `event_id_id` varchar(32) NOT NULL,
    `email` varchar(75) NOT NULL
)
;
ALTER TABLE `toss_event_emails` ADD CONSTRAINT `event_id_id_refs_id_388a5a18` FOREIGN
KEY (`event_id_id`) REFERENCES `toss_event` (`id`);

COMMIT;
```

After generating the proper sql tables in a database named toss, the application will be ready to go. The java created to access our database is reliably written but requires this precise structure. The django/python of course also requires the exact structure as it works on the database using model/class object style access and even the slightest change will make it not function at all.

5 Experimental results

Much of our testing was done by hand. Unit testing was not used outside of the default Maven unit tests. Each of the team members was responsible for testing his or her own section internally. Testing the

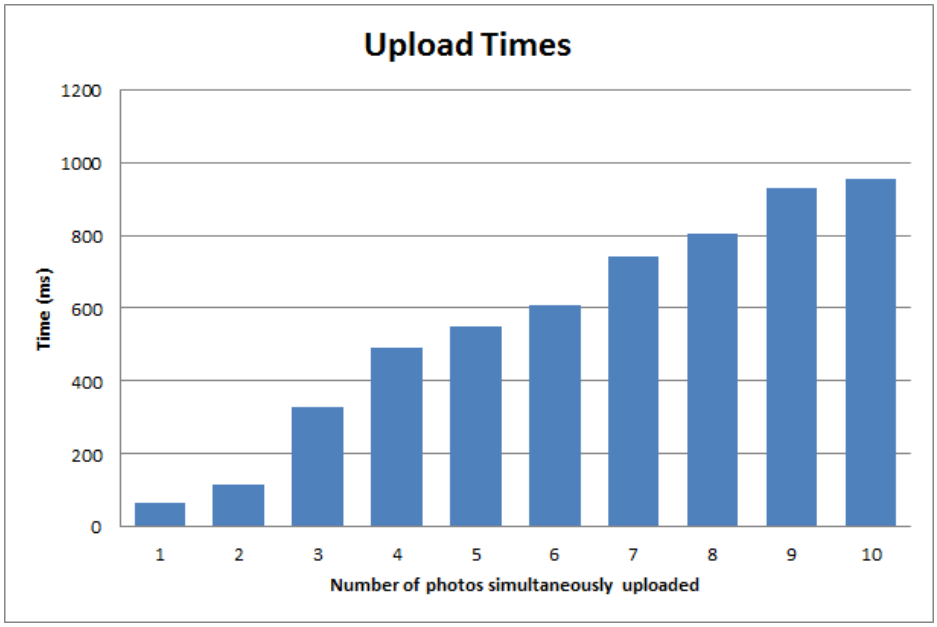
interactions between sections was performed by the owners of the processes. For example, testing done between the Android and Java backend (photo service and API layer) was performed by Greg and Patrick.

Website testing was performed by Kira. During development of the website, she would view the TOSS site, verify the feature she was developing performed as intended, and attempt to break the code with incorrect inputs. Some of the most intense debugging sessions for the website occurred while writing the Python socket code. The interaction between the website and the Java backend required diligent testing and thorough examination. Throughout development of the product, team members would use the website to create test events to verify their portions of the code. Having the entire team interacting with a 'rolling-release' style of website allowed us to provide feedback to Kira continuously. We were our own beta-testers. Minor cosmetic bugs (such as the 'Sumbit' button), functional bugs ('Logging in takes us back to the wrong page'), and UI changes ('background is too dark') were all reported by other members of the team and diligently fixed by Kira.

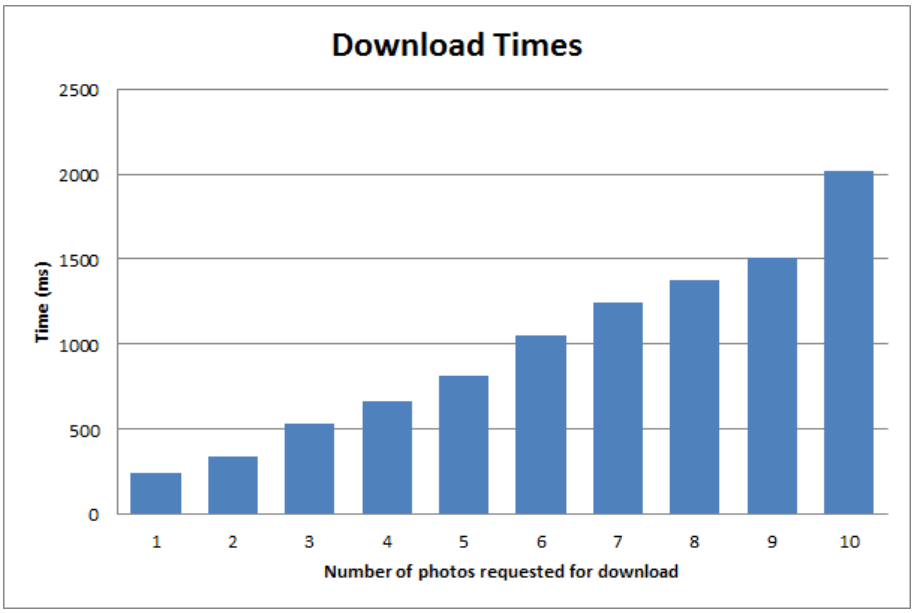
Zach was in charge of the administrative tasks concerning the server as well as photo uploading via email. During the project, he would monitor the server's ability to handle loads and react accordingly, killing processes that had become too memory-hungry or CPU-intensive. This ensured that our website ran smoothly and without incident. Email testing was performed while in development, like many of the other components of this project. Originally, the email photo-upload functionality required the user to send the md5 event ID as the subject line. Through testing, we were able to determine that this was likely going to be an area of trouble for the common user. Zach modified the Python email script to allow the user to input the 6 character event code, making it much more user-friendly.

Greg hand-tested every possible combination of event settings (FTP vs Dropbox, tagging enabled or not, etc), attempted to validate the event through the smartphone, and begin uploading pictures. Through this method, we were able to determine that both of the storage mediums worked well throughout the event from start to finish. Greg was also able to find and solve bugs concerning the global tagging mode and the user interface on the phone. Using many different event configurations let us test the correctness of the validation function contained in the Photo Service. After Greg created events with expired codes and codes that had not yet started, we were able to discover a few bugs in the validation function. We tested the photo-queuing ability of the Android app by taking several photos sequentially and uploading them to the server. In the original Design Validation specification, we had mentioned putting a hundred photos through the Android phone's queue. We did not test the app this extensively due to time limitations, but we saw no indication that a large queue of photos would inhibit the Android.

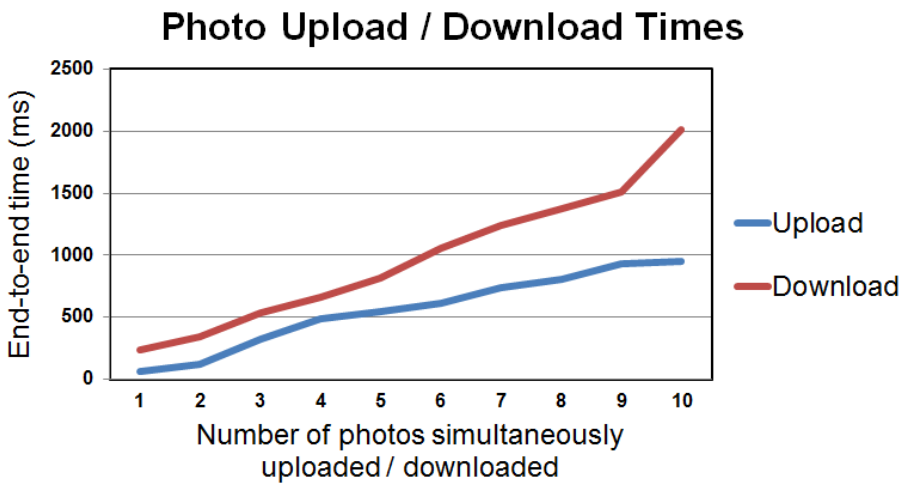
We did, however, test the capabilities of photo uploading between the website and API layer extensively. The website and API layer were able to easily handle uploads of 100 pictures simultaneously, taking roughly 31 seconds to complete the operation. A much more excessive test case of 1000 simultaneous photo uploads was attempted, which resulted in an OSerror number 24 (Too many open files) after three minutes of operation. A slightly more sane test of 500 simultaneous uploads was completed without incident after 2 minutes 31 seconds. The next test was 750 simultaneous photo uploads, which completed successfully 3 minutes 22 seconds. Timed tests on small upload/download amounts were also completed; the results are shown below. In these tests, one photo would be uploaded, then two photos at a time, then three...all the way up to ten photos at a time.



Upload times between the website and API layer. Each photo uploaded was an exact duplicate (the 'Penguins.jpg' contained in the Windows 7 Sample Pictures). Size: 760 KB



Download times recorded for the website/API layer. Again, the photos were exact duplicates ('Penguins.jpg').



Previous graphs shown on one axis.

These event times were tested using FTP using the same event, known as PatsEvent, which at the end of testing, contained 1678 photos at a total size of 1.3G. The extreme use of a single event for much of the stress-testing between TOSS components helped to prove an additional point: our databases have no problem with large events.

The time required for both upload and download progress linearly, as expected. The slight variations in time are caused by network latency, and do not deviate enough from the linear pattern to strongly affect upload or download times.

The validation function of the Photo Service was tested using the Android application and a Chrome browser extension known as Postman. The Photo Service, as mentioned before, uses REST to receive messages from the Android application. The REST call to validate an event code is:

http://toss.myphotos.cc:18081/validationService/1234AF

'1234AF' refers to the event code the user wishes to validate. The Photo Service will return a JSON string containing information relevant to the event code.


```
{
	"EventName":"ironflash test event 4",
	"ReturnCode":100,
	"TaggingEnabled":true,
	"EventStartTime":1395710580000,
	"EventID":"3dfb34af3e230d2d0f9440679abe188d",
	"EventEndTime":1403140980000,
	"EventCode":"1234AF"
}
```


Here are the results for testing some of the various events we have created:

Code	Start	End	Disabled?	Return Code
NOTVAL	5/10/14	5/30/14	0	200
123456	3/2/14	5/8/14	0	100
TOSSME	4/27/14	4/28/14	0	200

12345AG	**4/14/14**	**6/4/14**	**1**	**200**
EXPIRE	**3/30/14**	**4/20/14**	**0**	**200**
FTPTES	**4/22/14**	**5/8/14**	**0**	**100**

Please note that the validation service testing was performed on 4/27/14.

A return code of 100 means the event is currently valid and active. A return code of 200 is a generic failure code. We could have split this return code into different numbers to allow for more detailed error messages (i.e. "Can not connect to an expired event"), but for simplicity's sake kept a single error return code. One interesting case to notice is the 'TOSSME' event. Even though today is 4/27/14, the validation function returned '200'. This was due to the specific time the event was set to start. The 'TOSSME' event was set to start at 20:47:00 today, but the current time is 17:38:00. An event that has the 'disabled' flag set to true will return 200 even if it is within valid time.

We did also have a small beta-testing group that used our program to collect photos for their event. Josh was a main part of AggieCon 45, and was able to demo our program among some of the Con-goers. Five users uploaded a grand total of twelve photos, which was somewhat under the expected turnout, but we were able to get feedback on the performance of the project. Greg's app was the most exposed to the users, since the event was already created and this was prior to photo downloading via the website. The only part of our product Con-goers had to interact with was the Android application. The app was successful, with the only complaint being that somebody got the error message 'Unfortunately, the TOSS server is not working'. This was due to a connectivity issue in the building where AggieCon was being held, and the Android app incorrectly informed the user that our server was down. The message was fixed to provide the user with correct information: 'Unable to communicate with the TOSS server'.

All in all, our product does what it promises: it converges all photos taken and sent with the corresponding event code, and allows users to download the photos collected by the entire group. The time constraints for events are correct. The restrictions on disabled events are correct. Banned devices are rightfully prevented from uploading more photos. The Photo Service and API layer can handle sufficiently large numbers of simultaneous uploads and downloads (750). Multiple storage mediums (Dropbox and FTP) may be chosen for any given event. The website went through multiple iterations, each one improving the usability and interface. Overall, our product is feature-complete.

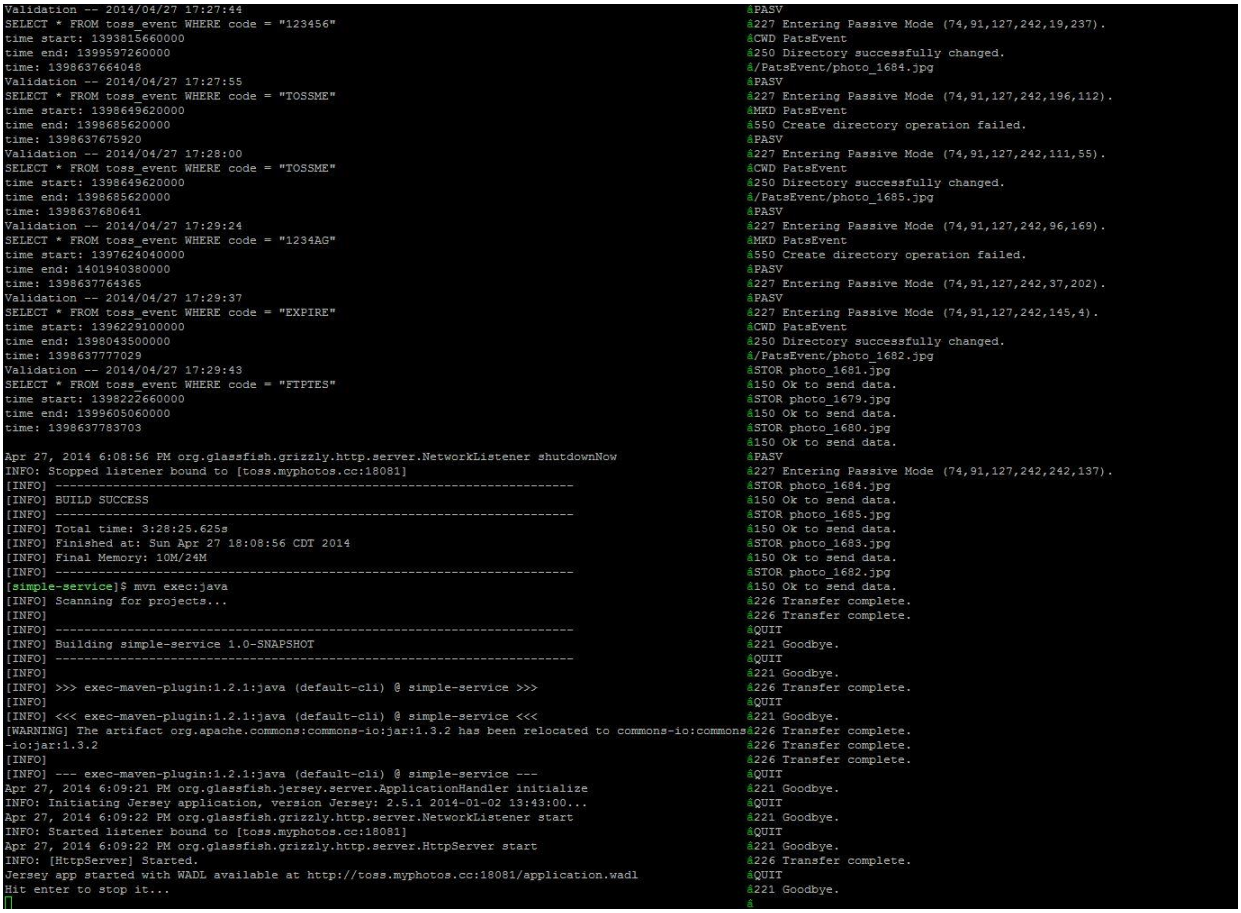


Photo Service and API layer shown running in a terminal window.

6 User's Manuals

Software Installation

The TOSS System is comprised of two components, a website and an Android application. In order to use the TOSS website users must have a browser installed capable of supporting JavaScript. In order to use the Android application users must have an Android device. To install the TOSS Android application users must download and install the TOSS application, available for free from the Google Play Store:

QR Code:

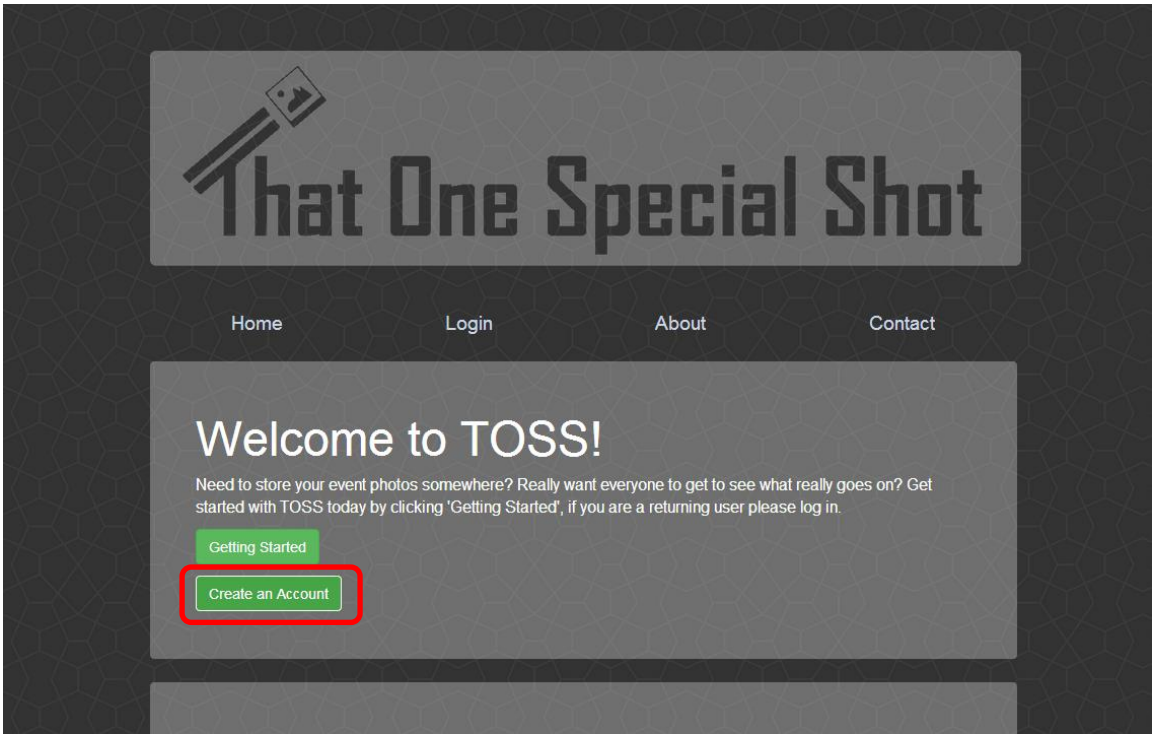
https://play.google.com/store/apps/details?id=com.toss.photocaptureapp

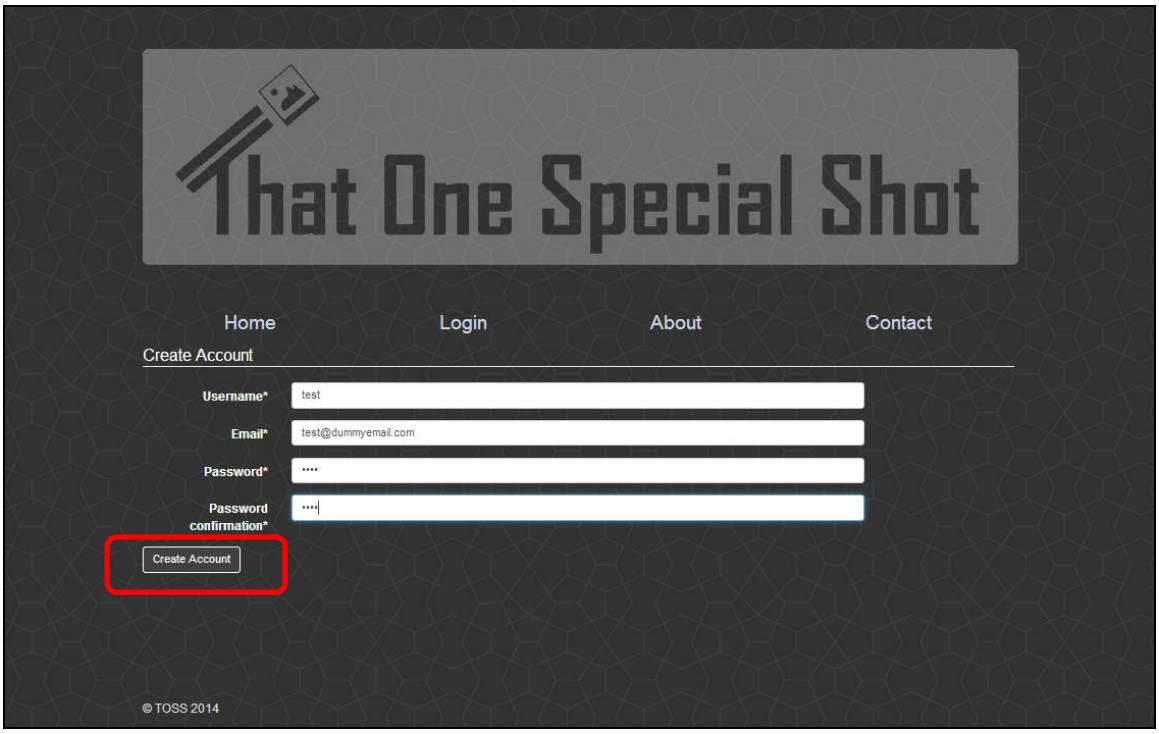
Operation Instructions

The operation instructions following will refer to a user wishing to create a TOSS event for their hosted event as ‘host’, and a user who is a guest of a TOSS event as a ‘guest’.

Creating an Account

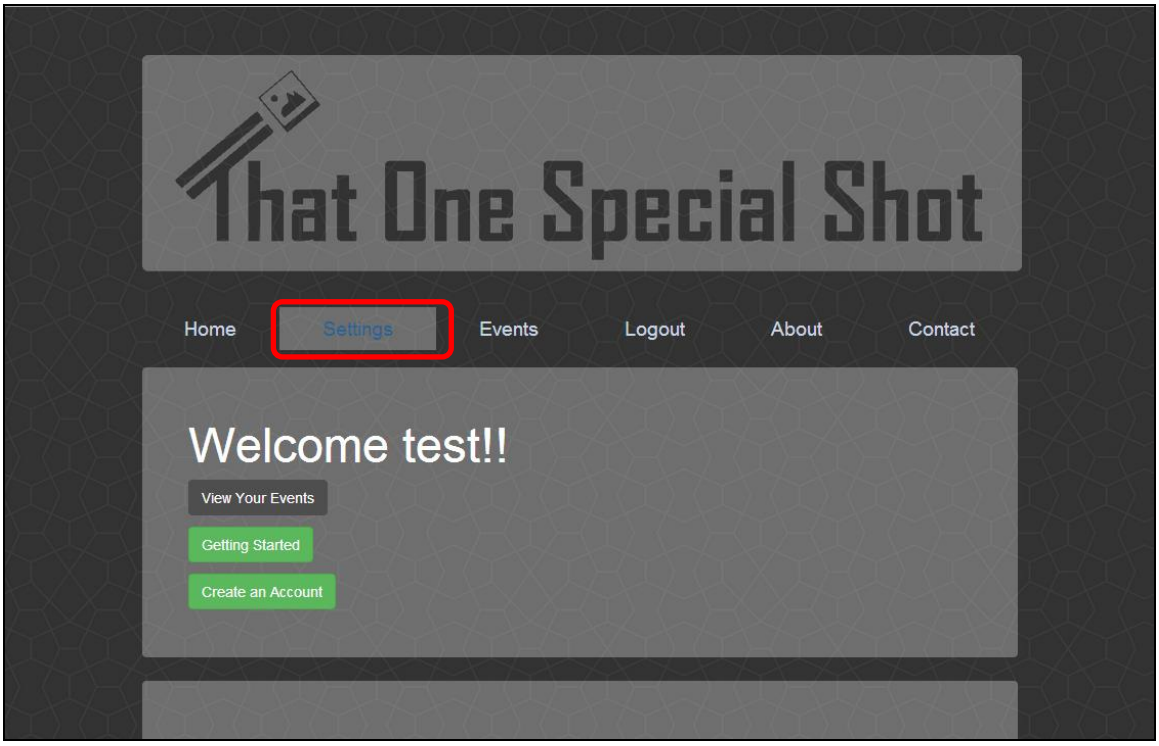
Hosts must first create an account on the TOSS website (www.toss.myphotos.cc). Guests do not have to create accounts.

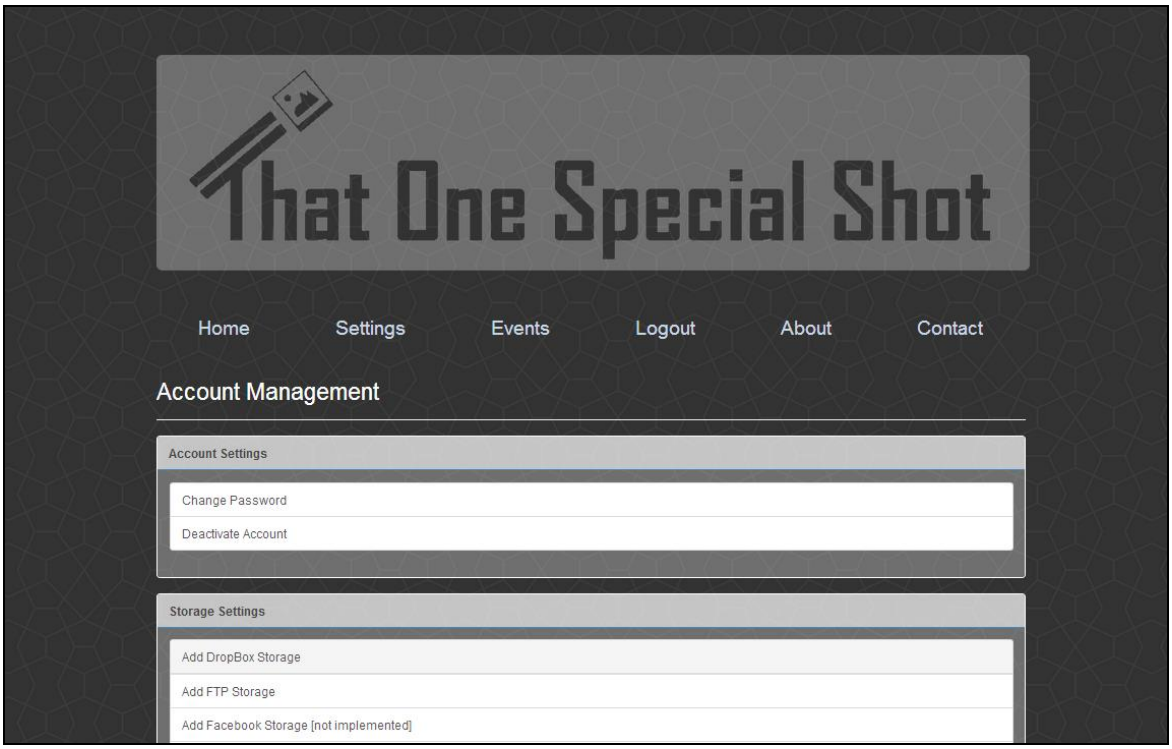

That One Special Shot
Home
Login
About
Contact
Welcome to TOSS!
Need to store your event photos somewhere? Really want everyone to get to see what really goes on? Get started with TOSS today by clicking 'Getting Started', if you are a returning user please log in.
Getting Started
Create an Account



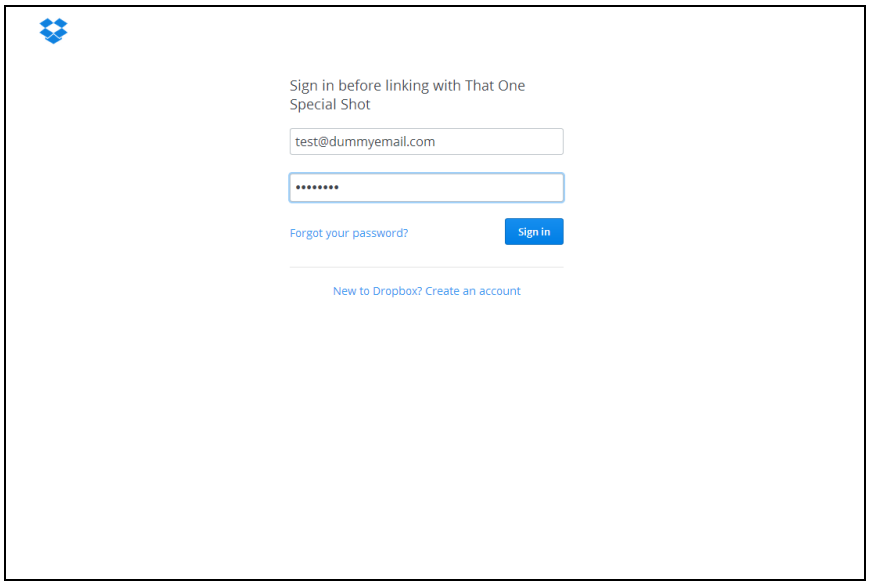
Adding Storage Services

After account creation hosts will need to add a storage service for TOSS to use to store event photos. This storage service will be responsible for storing all of the photos gathered using TOSS. Storage services allow TOSS to operate freely by mitigating hosting and storage costs. TOSS currently supports DropBox, and FTP.



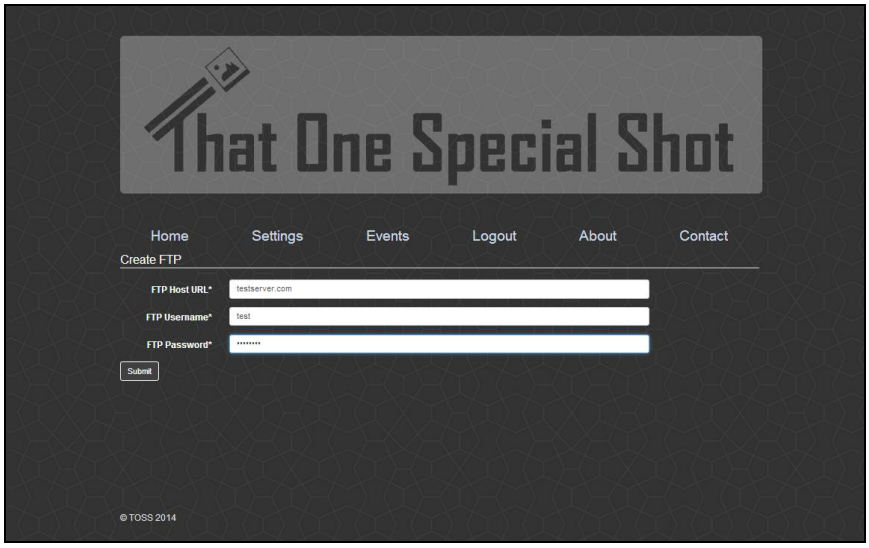


- **Dropbox**
  - Hosts must already have a Dropbox account. Adding permissions to Dropbox grants TOSS the ability to create folders and store photos on the Dropbox account.
  - Photos will be stored in the 'Apps/That One Special Shot/[Event Name]' directory of the Dropbox folder.


Sign in before linking with That One Special Shot
test@dummyemail.com
Forgot your password?
Sign in
New to Dropbox? Create an account

- **FTP**

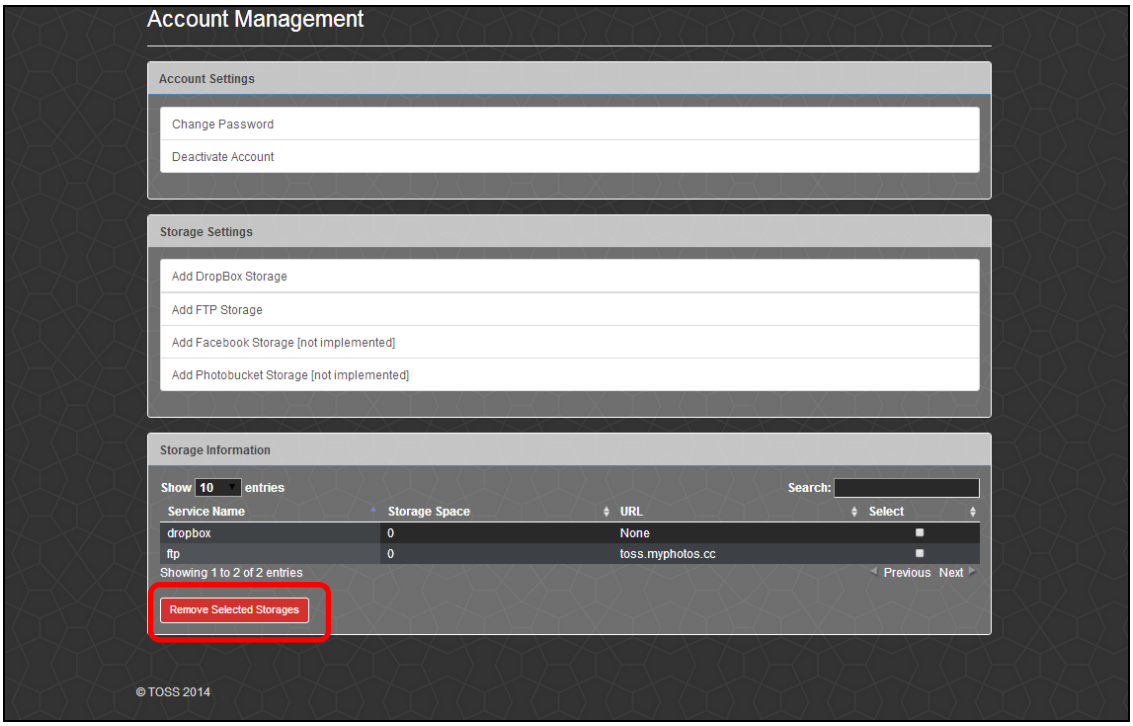
- Hosts must already have a server to connect to by FTP. Adding permissions to FTP grants TOSS the ability to create folders and store photos using the credentials and server provided. The provided credentials should have permissions to read and write on the provided server.
- Photos will be stored in the home directory of the server inside [Event Name].



Editing Storage Services

Only one of each storage service can be added to an account. Adding a duplicate storage service such as DropBox will replace the previous credentials with the new ones.

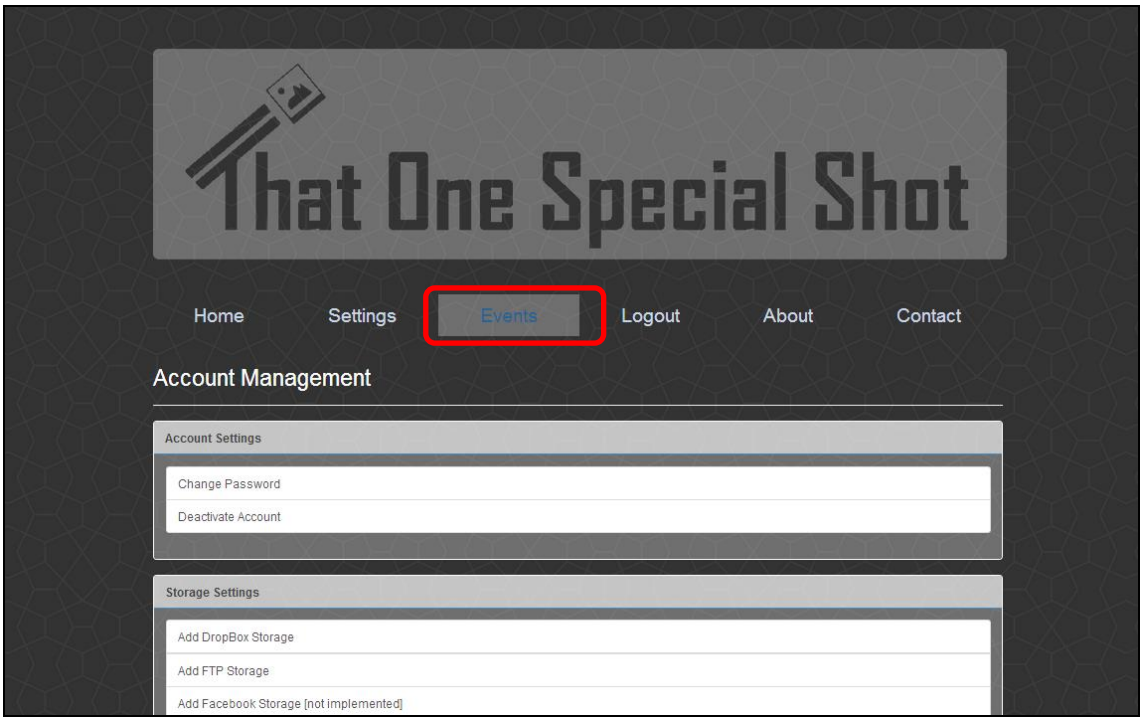
Storage services can be deleted at any time however TOSS events relying on that storage service will have their photos deleted from TOSS. Note that these photos will still remain as they were in the storage itself, but they will no longer be accessible through the TOSS website. In addition, the TOSS event will no longer be able to be uploaded to until a new storage is provided for that event by editing the event.

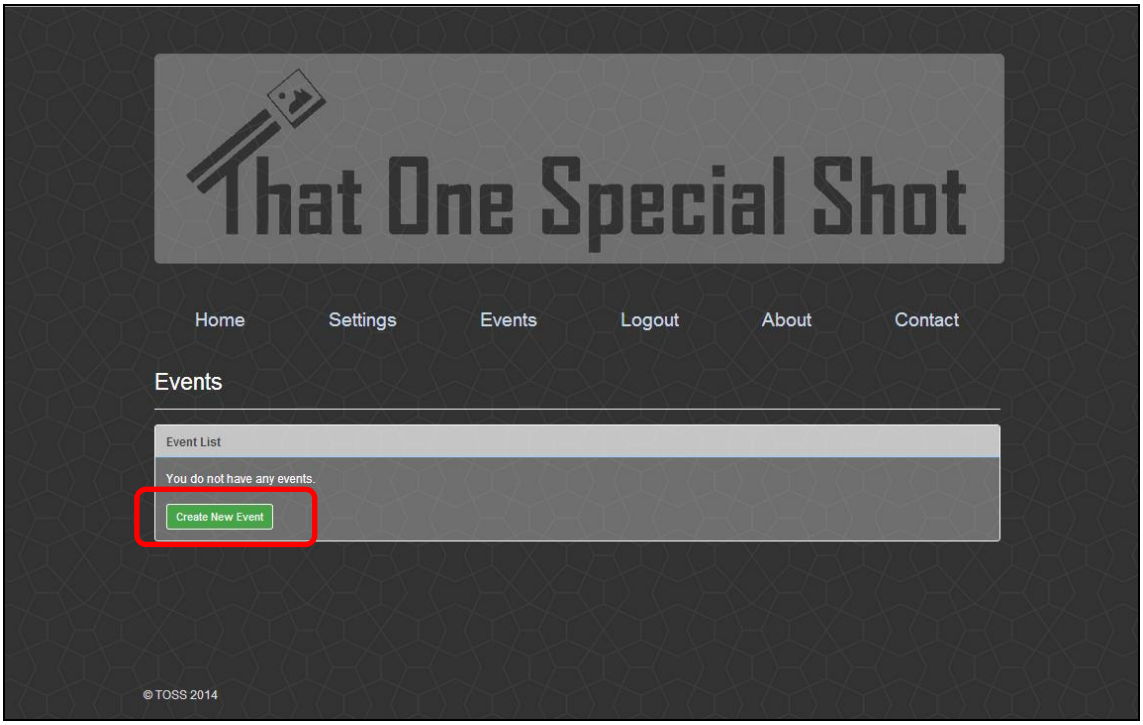


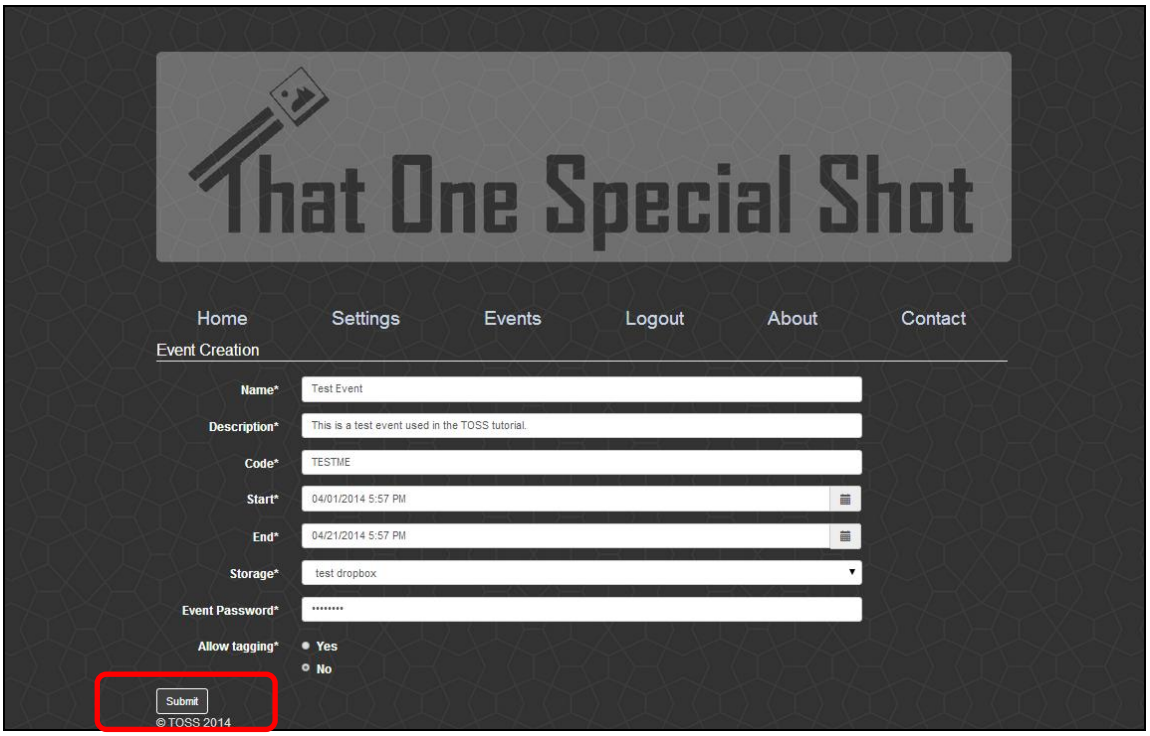
Creating an Event

After storage service additions hosts will need to create a TOSS event to correspond with their hosted event. An event has the following major components:

- **Code**
  - Each TOSS event will have a unique 6 digit code chosen by the host. Hosts will provide either this code or a QR of the code to guests. This code will be required to access the TOSS event for uploading photos through the TOSS mobile application.
  - Event codes can be updated at any time, freeing that code's use to any other TOSS event.
- **Storage**
  - Each TOSS event will have a corresponding storage service in which TOSS stores the event's photos.
  - Storage services can be updated at any time however all existing photos in that event with that storage medium will be removed from the database.
- **Event ID and Password**
  - Each TOSS event will be auto-assigned a permanent event ID. Hosts will provide this event ID and a password of their choosing to guests. These credentials will be required by guests to access the TOSS event's webpage on the TOSS website.
  - Event ID and password are permanent and cannot be changed.

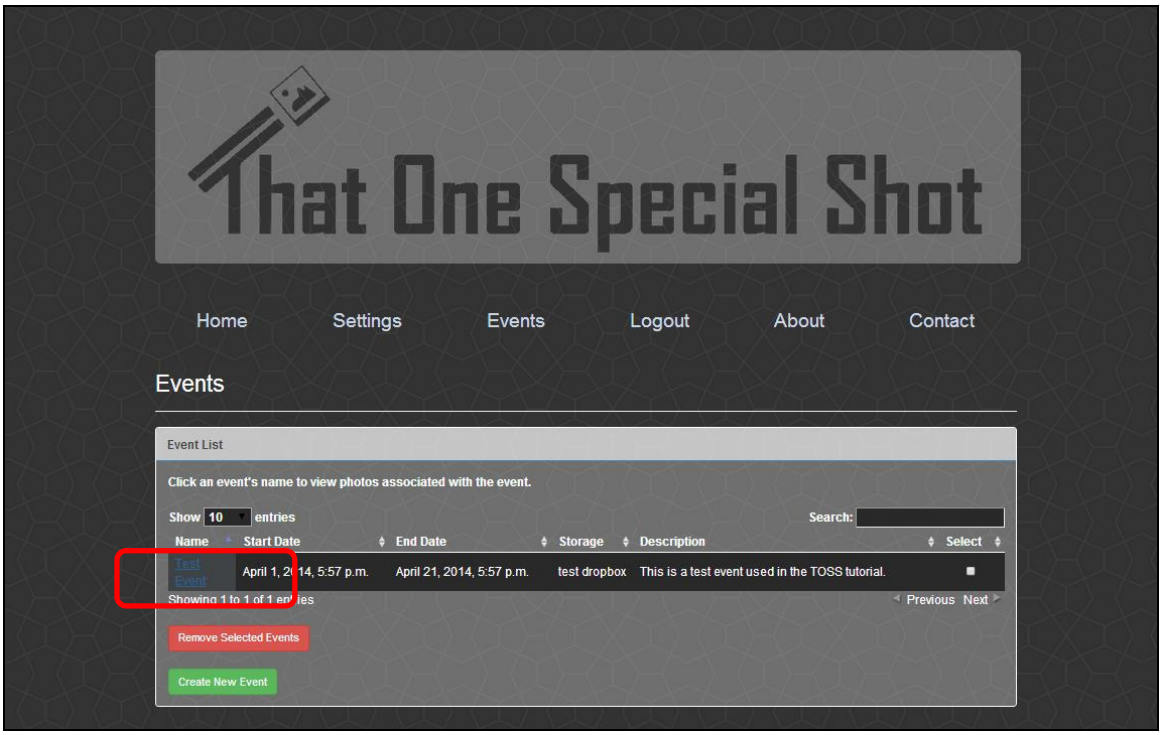

That One Special Shot
Home
Settings
Events
Logout
About
Contact
Account Management
Account Settings
Change Password
Deactivate Account
Storage Settings
Add DropBox Storage
Add FTP Storage
Add Facebook Storage [not implemented]

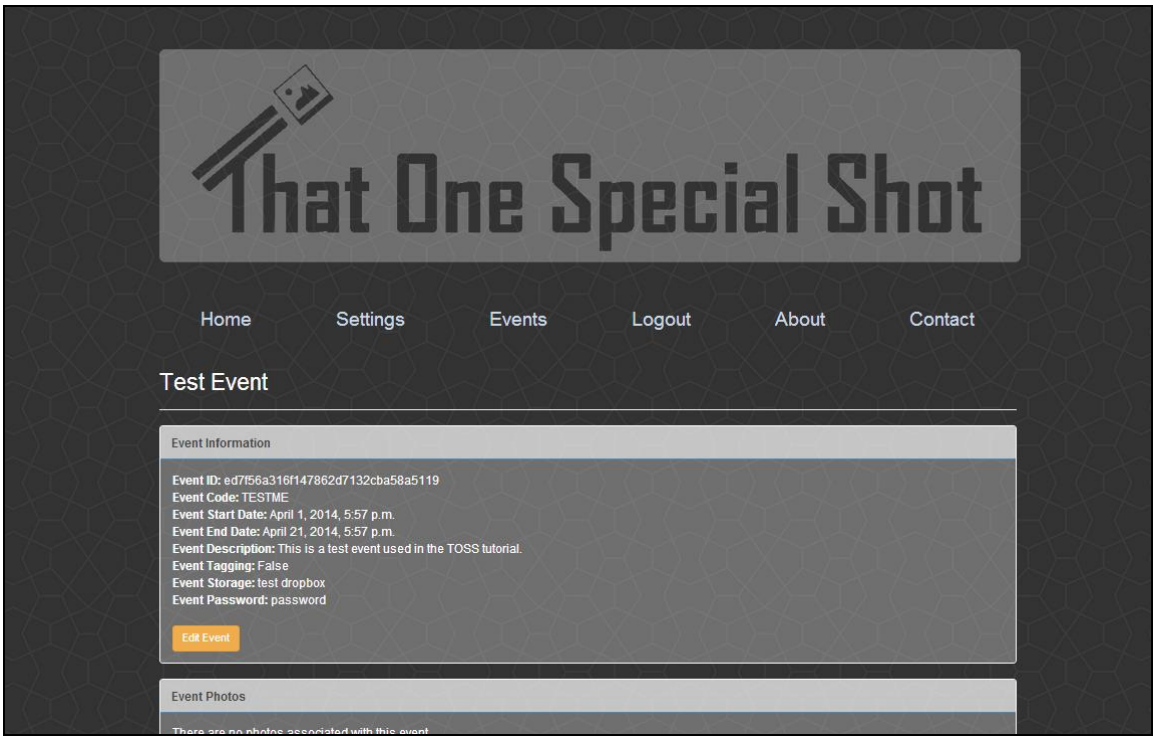

That One Special Shot
Home
Settings
Events
Logout
About
Contact
Events
Event List
You do not have any events.
Create New Event
© TOSS 2014



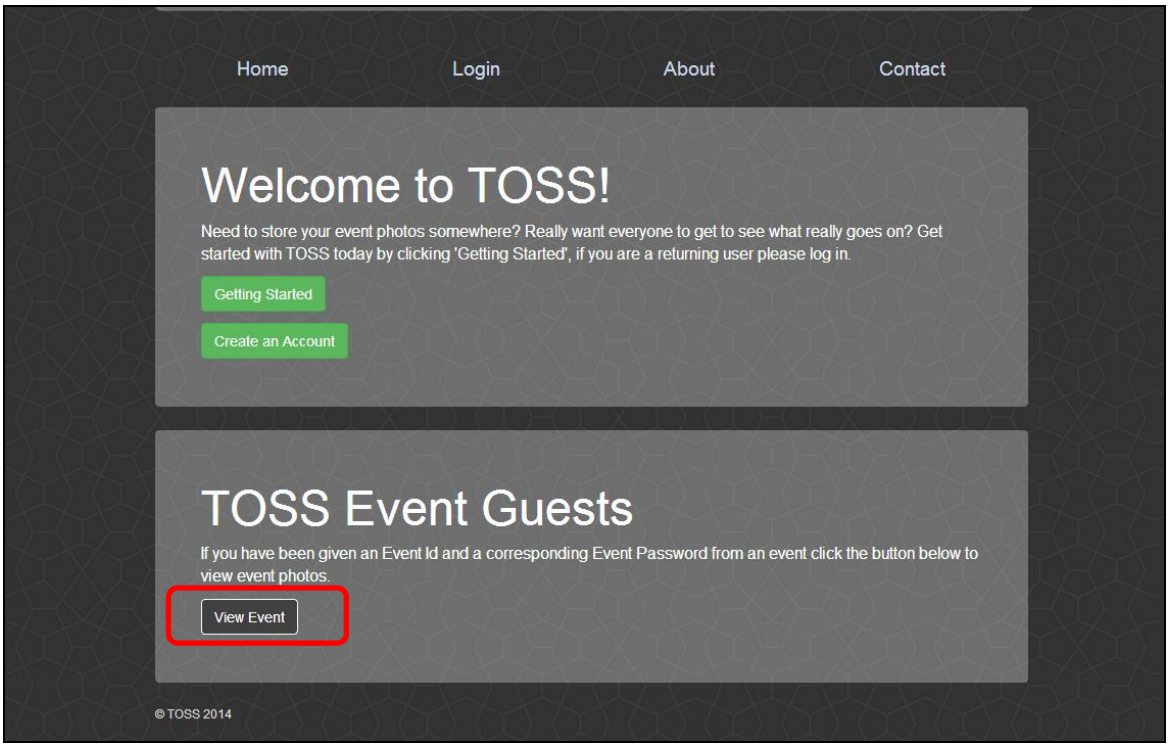
Viewing an Event

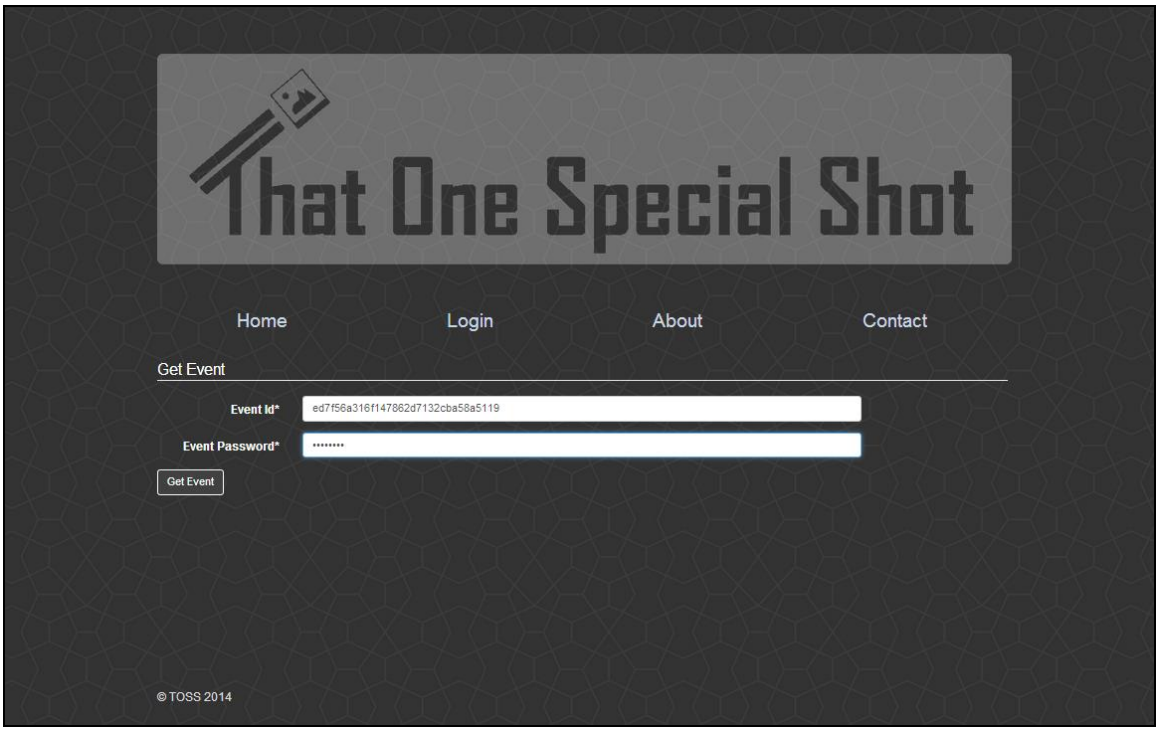
Hosts can view all of their created events through the Events tab of the TOSS website. The event name links to its respective event page. The event webpage allows hosts to edit the event, ban and unban devices, download photos, and upload photos.

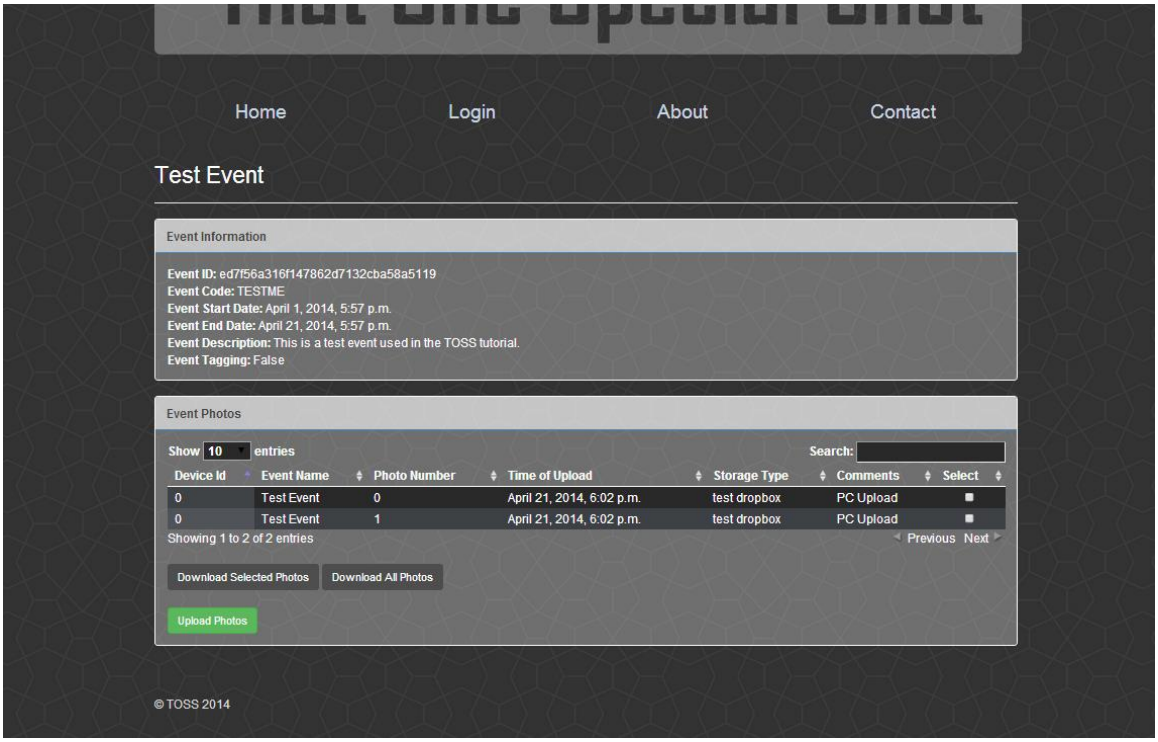




Guests can view a TOSS event with the event ID and password provided to them by the host. The event webpage allows guests to upload photos, view event photos, and download event photos.


Home
Login
About
Contact
Welcome to TOSS!
Need to store your event photos somewhere? Really want everyone to get to see what really goes on? Get started with TOSS today by clicking 'Getting Started', if you are a returning user please log in.
Getting Started
Create an Account
TOSS Event Guests
If you have been given an Event Id and a corresponding Event Password from an event click the button below to view event photos.
View Event
© TOSS 2014

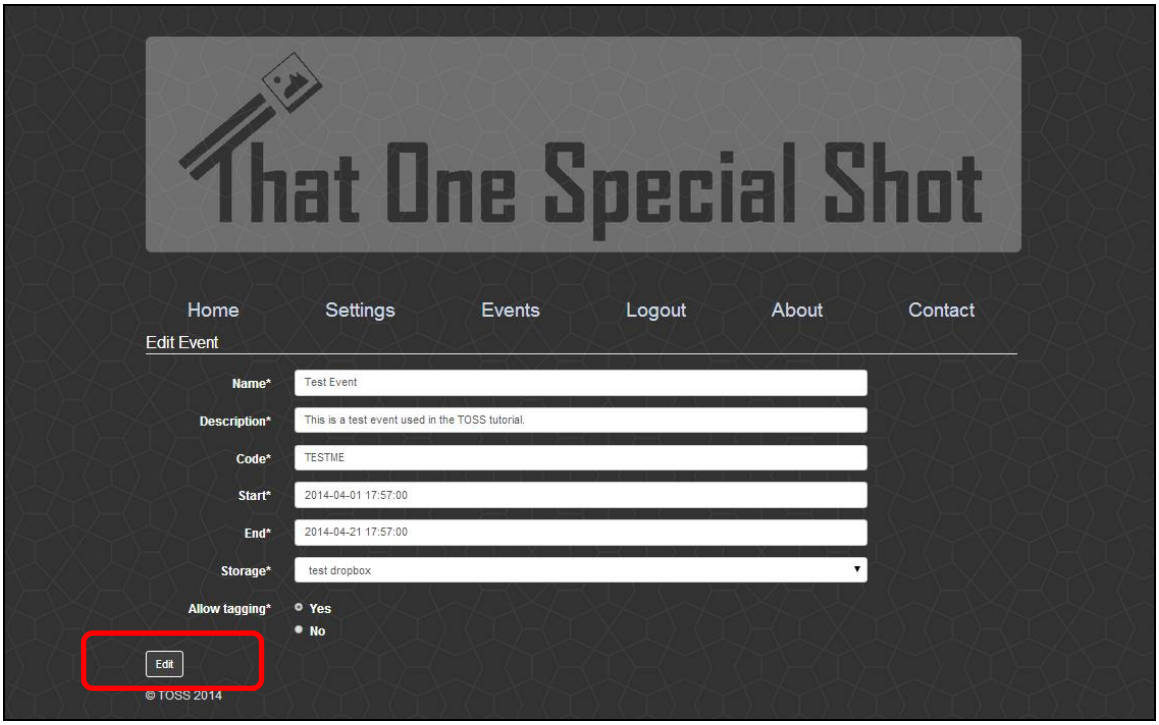




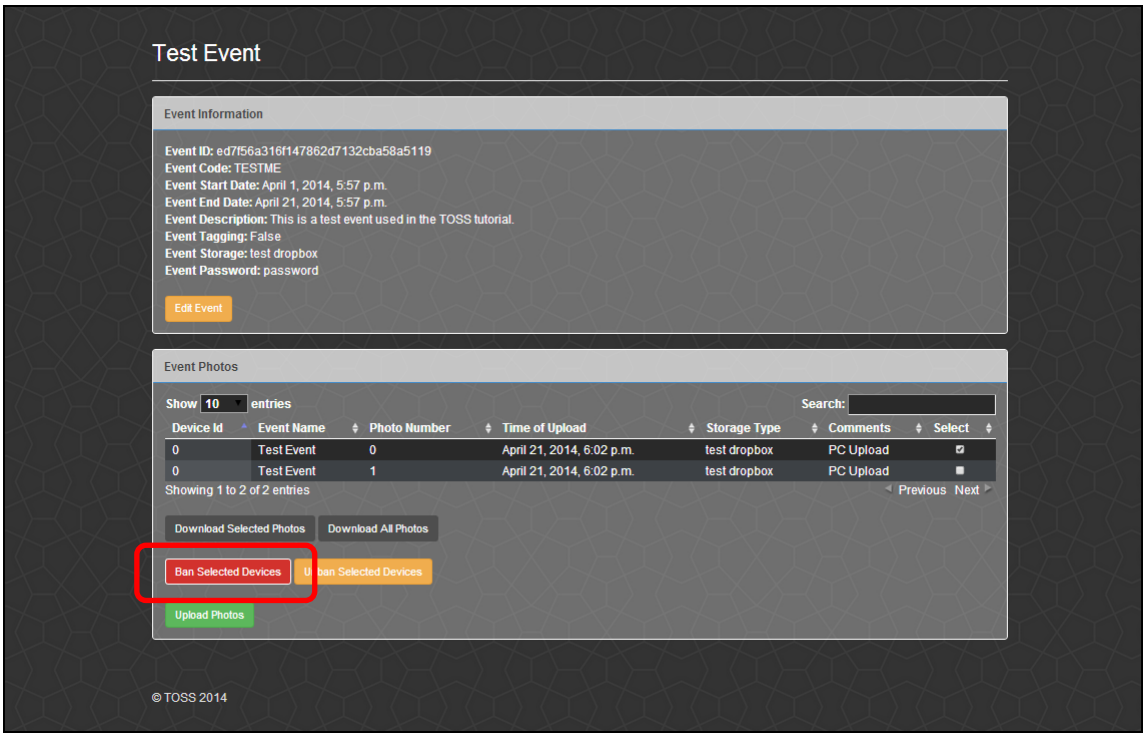
Editing an Event

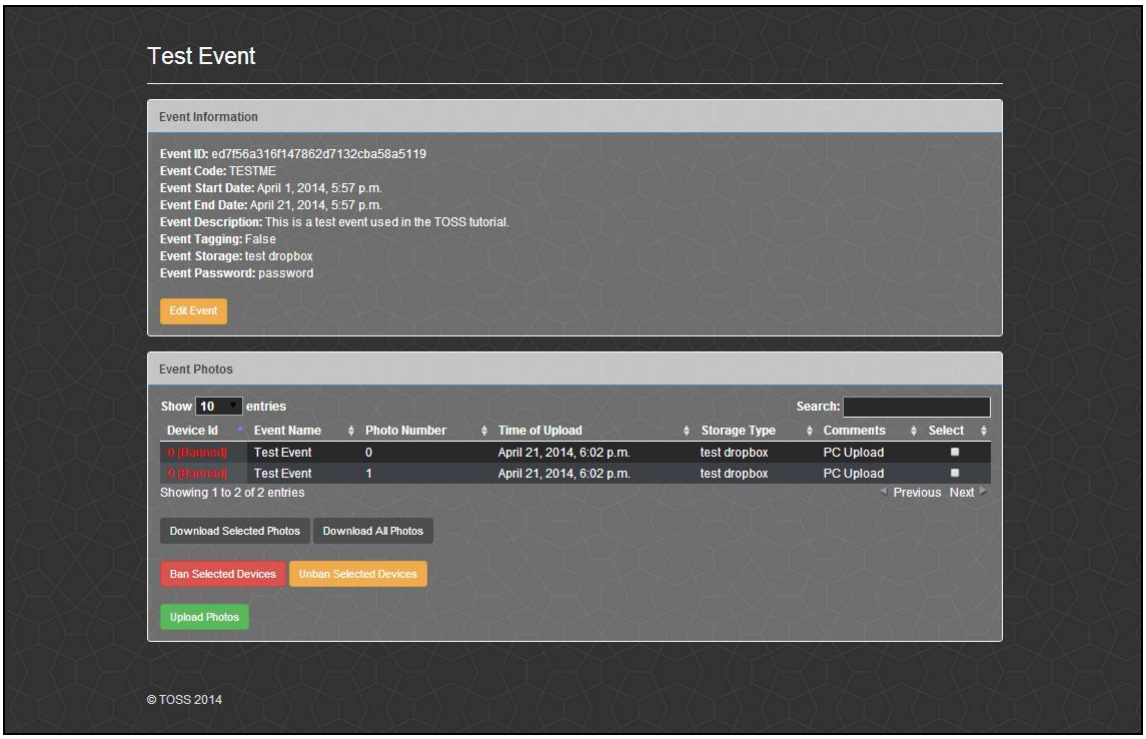
TOSS events can be edited at any time. All of the event's attributes can be edited except for the event ID, and the event password, these values are permanent. Changing the event code will change the code required by guests to upload photos to that event. Changing the event storage will remove all existing event photos from TOSS (note that this does not remove the photos from the storage service it only makes them inaccessible from the TOSS website), future photo uploads

will be stored on the new storage service .Changing the event tagging will change the tagging availability for any future photo uploads.



Hosts can also ban and unban device IDs from their TOSS event. Banning a device ID will block the corresponding Android device from uploading any photos to that particular event. Existing photos by the banned device ID will be marked in red text meaning they will not be viewable or downloadable by guests. Unbanning a device ID will restore that device's upload capabilities and also make existing photos uploaded by that device available for viewing and downloading by guests once more. Note that device ID 0 is reserved for website uploads. Banning device ID 0 will not prevent guests from uploading photos through the website however photos uploaded this way will not be available for guest viewing or download.




Test Event
Event Information
Event ID: ed7f56a316f147862d7132cba58a5119
Event Code: TESTME
Event Start Date: April 1, 2014, 5:57 p.m.
Event End Date: April 21, 2014, 5:57 p.m.
Event Description: This is a test event used in the TOSS tutorial.
Event Tagging: False
Event Storage: test dropbox
Event Password: password
Edit Event
Event Photos
Show 10 entries
Search:
Device Id
Event Name
Photo Number
Time of Upload
Storage Type
Comments
Select
0 [Banned] Test Event 0 April 21, 2014, 6:02 p.m. test dropbox PC Upload
0 [Banned] Test Event 1 April 21, 2014, 6:02 p.m. test dropbox PC Upload
Showing 1 to 2 of 2 entries
Previous Next
Download Selected Photos
Download All Photos
Ban Selected Devices
Unban Selected Devices
Upload Photos
© TOSS 2014

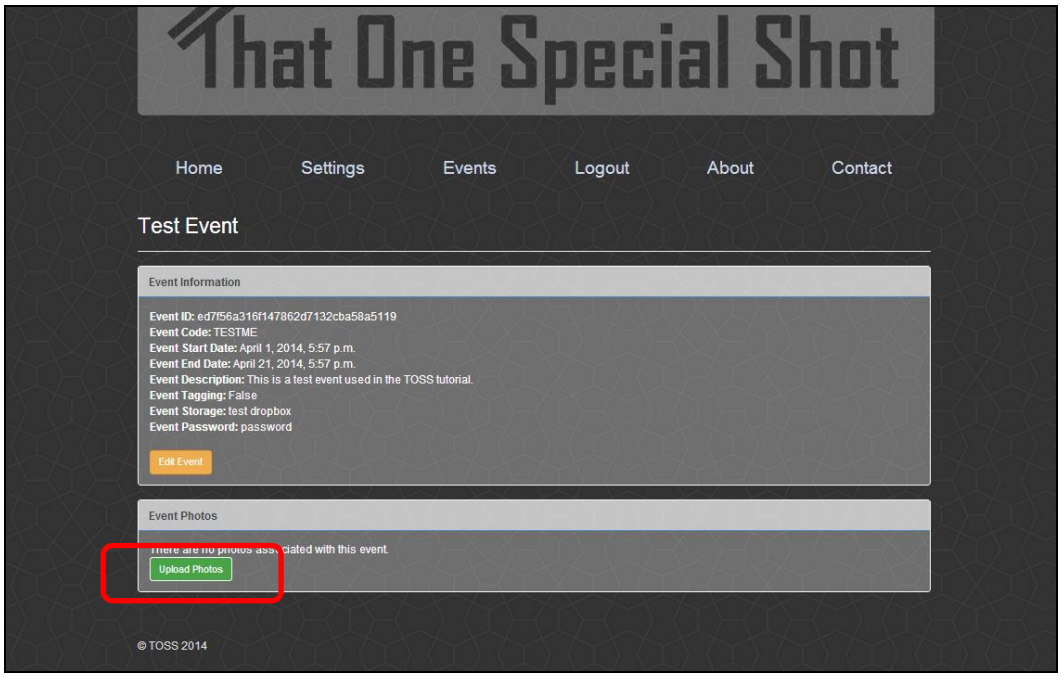
Uploading Photos to Events

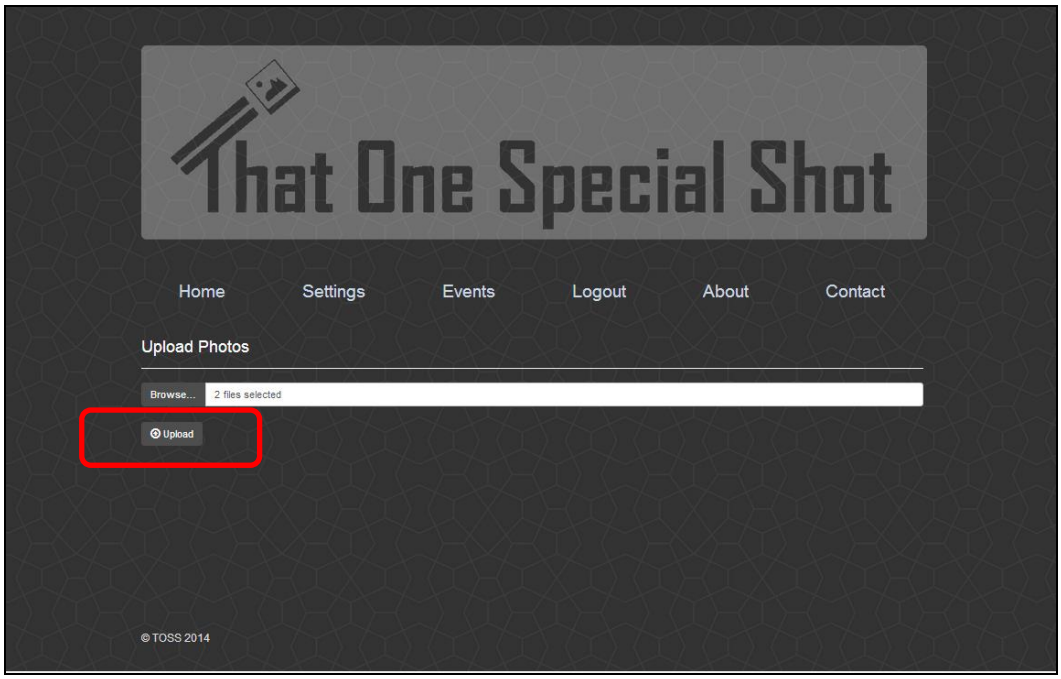
TOSS events can be uploaded to through the TOSS Android application, the TOSS website, or by email. The TOSS Android Application is available for free on the Google Play Store.

- **TOSS Android Application**

- The TOSS Android Application is available for free on the Google Play Store. The application will require either a 6 digit event code, or a QR Code to be scanned in order for TOSS to connect to a TOSS event. This code is created and distributed to guests by the event host. An in-depth tutorial for the TOSS application is available here or further down in this document.

- **TOSS Website**
  - TOSS events can be uploaded to through their corresponding event webpage on the TOSS Website. Hosts and guests can upload multiple photos from their computer. All photo extensions will be accepted however they will all be converted to .jpg. The photos uploaded this way will have their device ID set to 0, and their comment set to 'PC Upload'. The tagging and commenting options are not available through website upload.
  - Refer to the 'Viewing an Event' section of this user manual to access the event webpage.

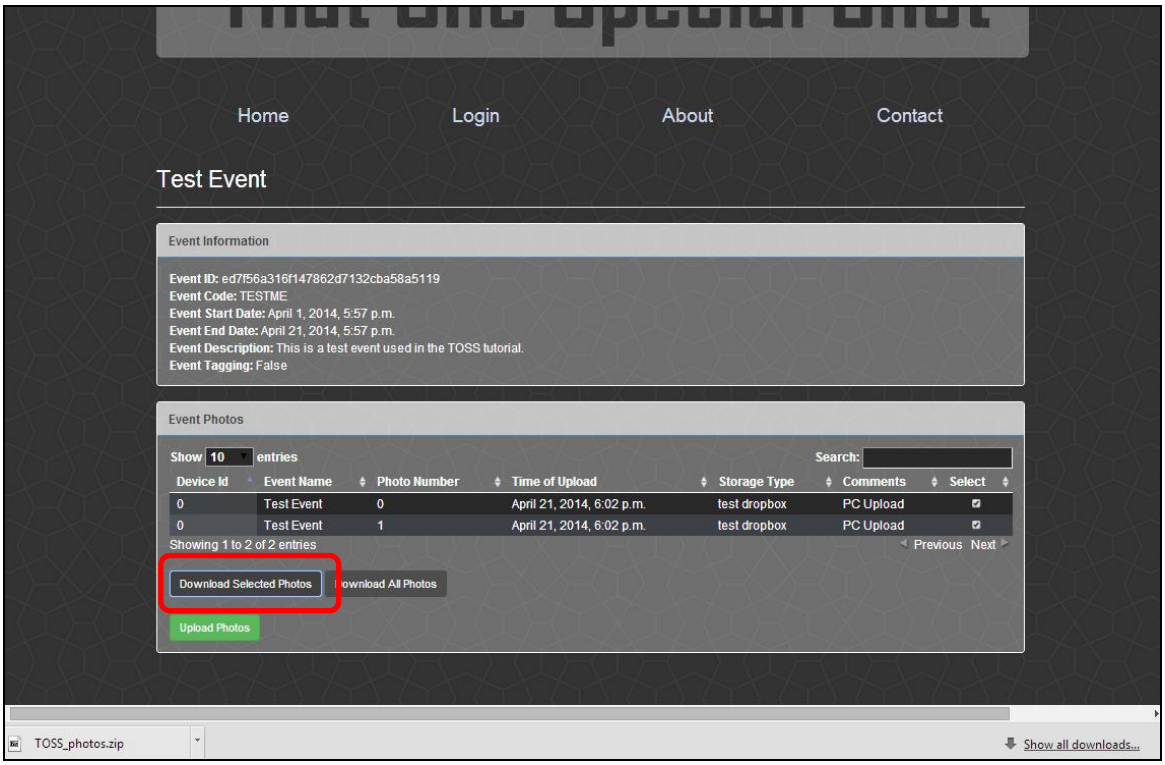




- **Email**
  - TOSS events can be uploaded to through email. Emails should be sent to 'toss@toss.myphotos.cc' with the subject line as either the TOSS event code, or the TOSS event id. The photos requiring upload can be attached individually up to 25 mega-bytes. Only jpg and png is supported, also no zip files will be excepted. If you receive a reply stating 'No image received' either the code or id provided is incorrect or the attachment extensions are not supported.

Downloading Photos from Events

TOSS event photos can be downloaded and viewed through the TOSS website. Clicking the 'Download Selected Photos' button will download all the photos selected using the checkbox column. Hosts will be able to download both unbanned and banned device ID photos in this fashion and Guests will only be able to download unbanned device ID photos. Clicking the 'Download All Photos' button will download all photos. Both hosts and guests will be able to download only unbanned device ID photos in this fashion. In both instances the photos will be automatically downloaded as a zip file called 'TOSS_photos.zip', do not deviate from this during the process or it will cancel the download.

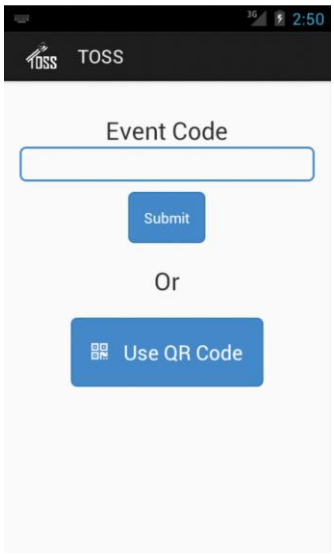


How to Use TOSS Android

Joining an event

Not currently joined to an event.

i. When starting the app the first screen that appears will be the following.



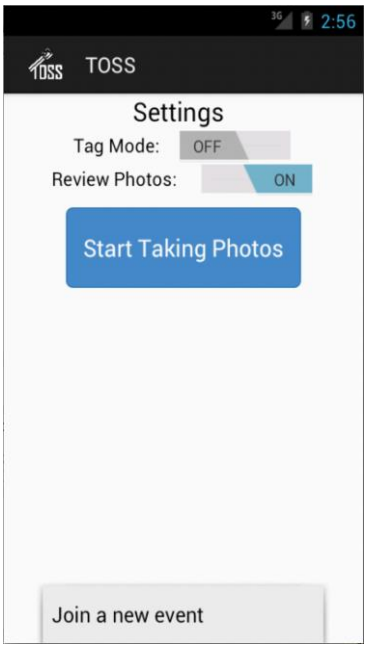
ii. Simply enter the 6 character code provided by the host

iii. Click Submit

iv. Optionally scan the QR code for the event instead of entering the code

Currently joined to an event

i. From the settings screen click the menu button on the phone



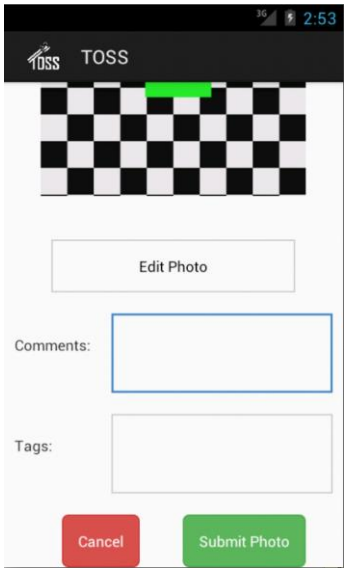
ii. From the setting select “Join a new event”

iii. Follow steps from the section “Not currently joined to an event”

Capture Modes

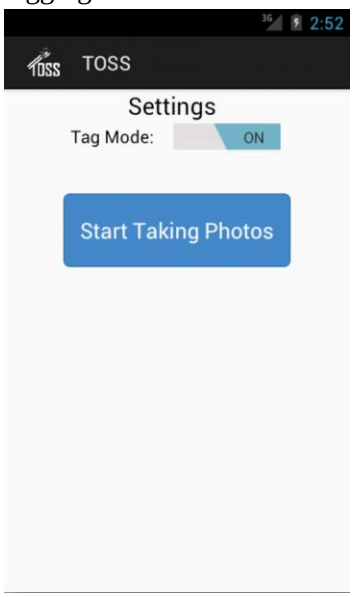
Tagging mode

Tagging mode allows the user to add tags and comments to a photo before it is uploaded. The tags can be used later when searching for the photo online. Tagging mode is a feature that can be disabled or enabled by the host of an event so it may not always be available. Tags may be separated by commas, spaces, or hash marks ‘#’.



Turning tagging mode on and off

i. From the setting screen there will be a switch titled “Tag Mode” if the event has tagging enabled



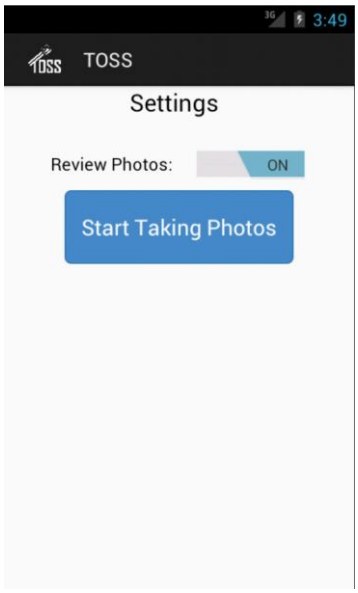
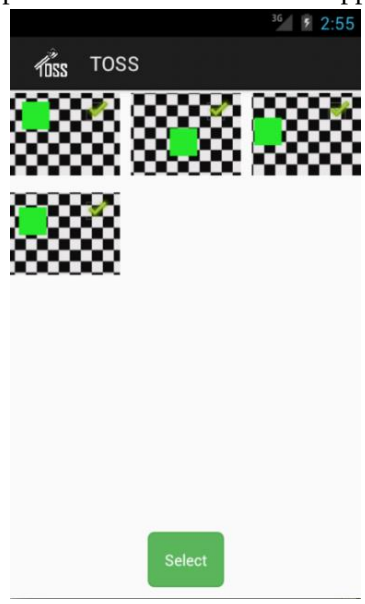


Photo Review Mode

Photo review mode can only be turned on when tagging mode is turned off. When photo review mode is on the user is allowed to take photos continually and then review them before uploading.

Using review mode

i. With review mode turned on start taking photos
ii. When done taking photos click back on the phone or close the camera application
iii. All the photos that were taken will appear

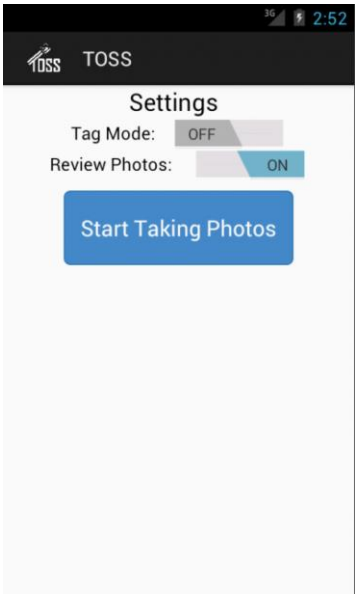


iv. Uncheck the photos that should not be uploaded

v. Click select to upload the photos that are checked

Turning photo reviewing on and off

When tag mode is turned off the switch for review mode will appear. Switch the switch to on to enable photo reviewing.



Instant Mode

Turning instant mode on and off

Instant mode in automatically turned on when both tagging mode and reviewing mode are off

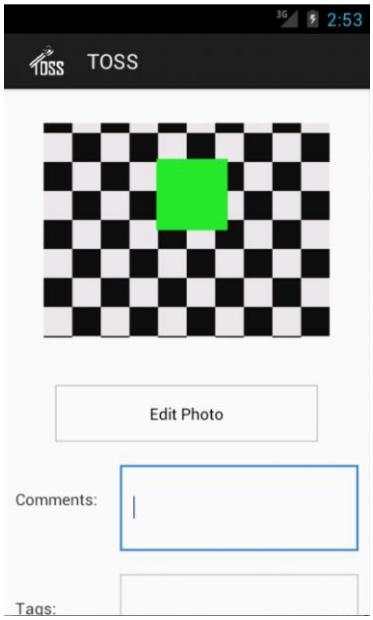
Photo Editing

Photos that are taken while in tagging mode and photo review mode can be edited using the built in Aviary photo editor.

How to edit a photo

From the tag screen

Click the “Edit Photo” button underneath the thumbnail of the photo



From the review photo screen
Click the photo thumbnail

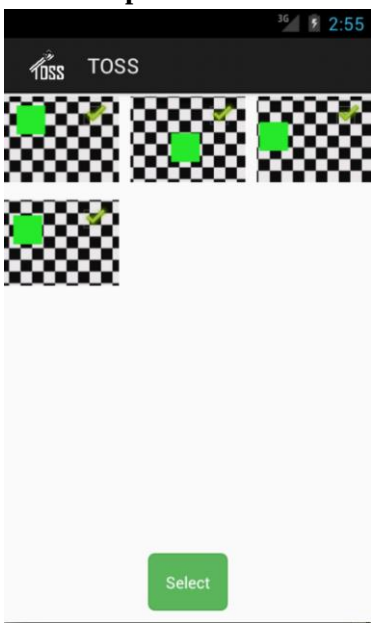
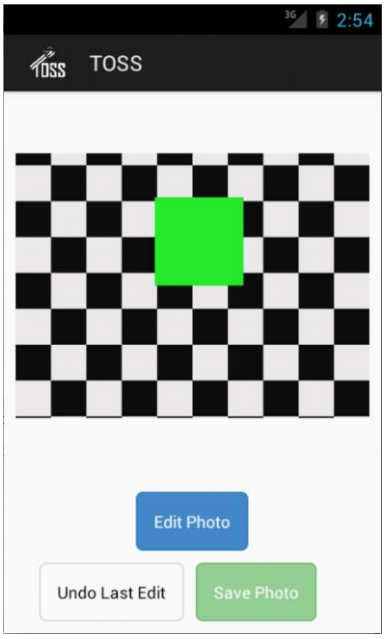
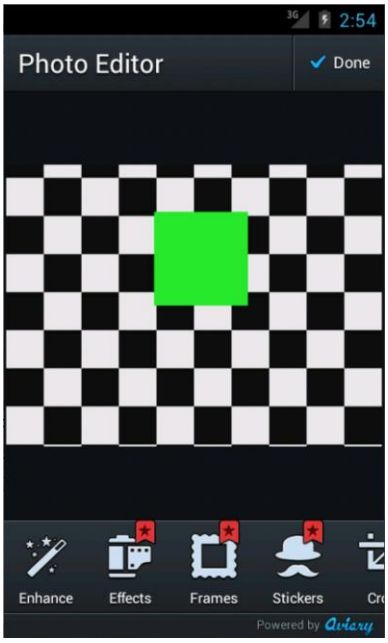


Photo edit screen

From this screen the currently edited photos can be seen. Until “Save Photo” is clicked changes will not be saved. User can undo changes by clicking the “Undo Last Edit” button. Clicking the “Edit Photo” will open up the Aviary photo editor with which the photo can be edited.



When done making changes to the photo click “Done”



7 Course debriefing

Team Management Style

The team lead came up with initial task breakdowns and assigned each individual tasks to complete. These tasks were well thought out and divided amongst members in equal distribution and with the person’s qualifications in mind. Each person was responsible for the tasks both specifically assigned to them as well as any side tasks that pertained to the main tasks. We kept communication open through Google Groups and Bitbucket commit messages. Through these communication outlets we each were able

to monitor the progress of all other tasks and were able to offer help to those progressing slowly when our own tasks were completed.

Thoughts on Repeating the Project

We would have spent more time ensuring that each team member understood the architecture of the system above their individual components especially the communication routes between components. We struggled with integrating our system components because some components were developed as stand-alone programs that required intensive integration and rewriting, and also because of coding language barriers between components. However, despite our difficulties with integration we were able to complete our system.

We also would have liked to have better coordination when it came to repository control and testing framework. Confusion concerning merging, branching, and committing to the repository could occasionally create problems. Creating a testing framework could have helped us benchmark our program more effectively as well as verify the correctness of our functions.

Safety and Ethical Concerns

The only real ethical or safety concern was privacy. Since the photos being taken at the event were being sent out and saved on a server both host and guest privacy could be breached. It may be possible that a guest might not want their photo being shared. To accommodate this concern we added the option of turning tagging on and off at an event level by the host of the event. This way the host can ensure that no one from the event is tagged in photos. Also we assume implicit consent to appear in event photos by guests at the event. Some other aspects that could affect privacy is the inclusion of meta-data in photos, which we did not have time to perform stripping on, and also our tracking of device ids which is required for device banning.

Testing the Product

Testing the product was mostly done by hand. We had little automated testing being done on any portion of our project. It might have been good to try a more test-driven development approach, just to see if we were missing out on anything. However, it should be mentioned that our testing-by-hand strategy was very effective. Many bugs were found and solved using this method. Many user interface improvements were also decided upon while hand-testing. The product works as it is intended, we were able to save time by hand-testing, and we were able to view and use the UI on a regular basis, allowing us to consistently improve it. We also tested TOSS during AggieCon. Although we only received 12 photos, we received a lot of outsider feedback on the user interface as well performance.

Testing procedures for the Android application included creating every possible combination of event settings and attempting to connect to each event to capture photos. Greg was able to verify that the storage options worked as well as the tagging option set at the event level. He also tested attempting to join events that had expired codes as well as codes that had not started yet. One aspect not thoroughly tested was the ability to for the application to handle large amounts of photos being sent to the Photo Service. Greg would have added unit testing given additional time.

Throughout developing the Web Service Kira tested each functionality she added by hand, using fake data. She was able to find and correct a lot of using this method. The team also found a lot of user-interface issues she had missed do to familiarity. The only aspect requiring more testing would be the upload and download of photos. Testing during development was difficult due to component incompatibilities so testing was rushed after development as it was one of the last tasks completed. The Web Service was developed on a separate database then the one the API Abstraction Layer was developed on.

8 Budgets

The budget remained relatively the same as the one proposed. We required the purchase of an additional Android Device, for development purposes as well as an android developer license for application distribution on the Google Play Store.

Due to the software nature of our product there are no associated costs for mass production. We do however require a virtual server to host our service which will require subscription costs as well as possible upgrade costs. These costs can be mitigated or subsidized through donations or advertisement placements on our website.

Product	**Quantity**	**Cost**
Virtual Server from NFOServers	6 Months	$52.45
Tomsplanner Subscription (Gant charts)	3 Months	$27.00
Android Developer License	1	$25.00
Android Device	1	$50.00
Possible Server Upgrade	Varies	Varies

Detailed Cost Breakdown